

**Attachments:**

Table 2306.3.1SPF.3<sup>rd</sup> Draft.xls

Table 2306.4.1SPF.4<sup>th</sup> Draft.xls

## **CHAPTER 23**

### **WOOD**

[Instructions to EDITOR in blue in brackets].

[Use the text given in this draft, except where sections are identified as being based on IBC 2003 or IBC 2004 Supplement. Where based on IBC 2003 or IBC 2004 supplement, start with IBC text and then make indicated corrections (strikeout = delete; underline = add)].

*This chapter is unique to Massachusetts*

### **SECTION 2301 GENERAL**

**2301.1 Scope.** The provisions of this chapter shall govern the materials, design, construction, and quality of wood members, systems, and structures, and their fasteners.

**2301.2 General requirements.** Except as otherwise provided in this chapter, the design and construction of wood components, systems, and structures shall be in accordance with the following listed standards for allowable stress design (ASD) or the following listed standards for load and resistance factor design (LRFD) (strength design):

#### **2301.2.1 Allowable Stress Design Standards:**

1. ANSI/AF&PA NDS (NDS)
2. AF&PA ASD Panel Supplement

#### **2301.2.2 Load and Resistance Factor Design Standards:**

1. AF&PA/ASCE 16 (ASCE 16)
2. AF&PA LRFD Lumber Supplement
3. AF&PA LRFD Connections Supplement
4. AF&PA LRFD Laminated Timber Supplement
5. AF&PA LRFD Panel Supplement, except Section 5.3, and Tables 5.4 and 5.5

### **SECTION 2302 DEFINITIONS**

**2302.1 General.** The following definitions shall apply to the provisions of this chapter.

**ACCREDITATION BODY.** An approved, third-party organization that is independent of the grading and inspection agencies and the lumber mills, and that initially accredits and subsequently monitors, on a continuing basis, the competency and performance of a grading or inspection agency related to carrying out specific tasks.

**BOUNDARY ELEMENT.** Diaphragms and shear wall boundary members to which sheathing transfers forces. Boundary elements include chords and drag struts at diaphragm and shear wall perimeters, interior openings, discontinuities and re-entrant corners.

**COLLECTOR.** A horizontal diaphragm element parallel and in line with the applied force that collects and transfers diaphragm shear forces to the vertical elements of the lateral-force-resisting system and/or distributes forces within the diaphragm.

**CONVENTIONAL LIGHT-FRAME WOOD CONSTRUCTION.** A type of construction whose primary structural elements are formed by a system of repetitive wood-framing members.

**CRIPPLE WALL.** A framed stud wall extending from the top of the foundation to the underside of floor framing for the lowest occupied floor level.

**DIAPHRAGM.** A horizontal or nearly horizontal system acting to transmit lateral forces to the vertical-resisting elements. When the term “diaphragm” is used, it includes horizontal bracing systems.

**DIAPHRAGM, BLOCKED.** A diaphragm in which adjacent sheathing edges not occurring over framing are supported on and fastened to common blocking members.

**DIAPHRAGM, BOUNDARY.** A location where shear is transferred into or out of the diaphragm sheathing. Transfer is either to a boundary element or to another force-resisting element.

**DIAPHRAGM, CHORD.** A diaphragm boundary element perpendicular to the applied load that is assumed to take axial stresses due to the diaphragm moment.

**DIAPHRAGM, UNBLOCKED.** A diaphragm that has edge nailing at supporting members only. Blocking between supporting structural members at panel edges is not included. Diaphragm panels are field nailed to supporting members.

**DRAG STRUT.** See “Collector.”

**FIBERBOARD.** A fibrous, homogeneous panel made from lignocellulosic fibers (usually wood or cane) and having a density of less than 31 pounds per cubic foot (497 kg/m<sup>3</sup>) but more than 10 pounds per cubic foot (160 kg/m<sup>3</sup>).

**GLUED BUILT-UP MEMBER.** A structural element, the section of which is composed of built-up lumber, wood structural panels or wood structural panels in combination with lumber, all parts bonded together with structural adhesives.

**GRADE (LUMBER).** The classification of lumber in regard to strength and utility in accordance with DOC PS 20 and the grading rules of an approved lumber rules writing agency.

**HARDBOARD.** A fibrous-felted, homogeneous panel made from lignocellulosic fibers consolidated under heat and pressure in a hot press to a density not less than 31 pounds per cubic foot (497 kg/m<sup>3</sup>).

**NAILING, BOUNDARY.** A special nailing pattern required by design at the boundaries of diaphragms.

**NAILING, EDGE.** A special nailing pattern required by design at the edges of each panel within the assembly of a diaphragm or shear wall.

**NAILING, FIELD.** Nailing required between the sheathing panels and framing members at locations other than boundary nailing and edge nailing.

**NATIVE LUMBER.** Native lumber is wood processed in the Commonwealth of Massachusetts by a mill registered in accordance with 780 CMR R4. Such wood may be ungraded but is stamped or certified in accordance with the requirements of 780 CMR R-4.

**NATURALLY DURABLE WOOD.** The heartwood of the following species with the exception that an occasional piece with corner sapwood is permitted if 90 percent or more of the width of each side on which it occurs is heartwood.

**Decay resistant.** Redwood, cedar, black locust and black walnut.

**Termite resistant.** Redwood and Eastern red cedar.

**NOMINAL SIZE (LUMBER).** The commercial size designation of width and depth, in standard sawn lumber and glued laminated lumber grades; somewhat larger than the standard net size of dressed lumber, in accordance with DOC PS 20 for sawn lumber and in accordance with the NDS for glued laminated lumber.

**PARTICLEBOARD.** A generic term for a panel primarily composed of cellulosic materials (usually wood), generally in the form of discrete pieces or particles, as distinguished from fibers. The cellulosic material is combined with synthetic resin or other suitable bonding system by a process in which the interparticle bond is created by the bonding system under heat and pressure.

**PERFORATED SHEAR WALL.** A section of shear wall with full-height sheathing that meets the height-to-width ratio limits of Section 2305.3.3.

**PERFORATED SHEAR WALL SEGMENT.** A section of shear wall with full-height sheathing that meets the aspect ratio limits of Section 2305.3.3.

**PRESERVATIVE-TREATED WOOD.** Wood (including plywood) pressure-treated with preservatives in accordance with Section 2303.1.8.

**SHEAR WALL.** A wall designed to resist lateral forces parallel to the plane of a wall.

**STRUCTURAL GLUED LAMINATED TIMBER.** Any member comprising an assembly of laminations of lumber in which the grain of all laminations is approximately parallel longitudinally, in which the laminations are bonded with adhesives.

**SUBDIAPHRAGM.** A portion of a larger wood diaphragm designed to anchor and transfer local forces to primary diaphragm struts and the main diaphragm.

**TIE-DOWN (HOLD-DOWN).** A device used to resist uplift of the chords of shear walls.

**TREATED WOOD.** Wood impregnated under pressure with compounds that reduce their susceptibility to flame spread or to deterioration caused by fungi, insects, or marine borers.

**WOOD SHEAR PANEL.** A wood floor, roof, or wall component sheathed to act as a shear wall or diaphragm.

**WOOD STRUCTURAL PANEL.** A panel manufactured from veneers; or wood strands or wafers; or a combination of veneer and wood strands or wafers; bonded together with waterproof synthetic resins or other suitable bonding systems. Examples of wood structural panels are:

**Composite Panels.** A structural panel that is made of layers of veneer and wood-based material;

**Oriented Strand Board (OSB).** A wood structural panel that is a mat-formed product composed of thin rectangular wood strands or wafers arranged in oriented layers; and

**Plywood.** A wood structural panel comprised of plies of wood veneer arranged in cross-aligned layers.

## **SECTION 2303 SUPPLEMENTAL REQUIREMENTS**

**2303.1 General.** Section 2303 supplements the requirements in the referenced standards of Section 2301.2.

### **2303.2 Lumber.**

**2303.2.1 Standard.** Lumber and lumber grading shall comply with DOC PS 20

**2303.2.2 Alternate grading.** In lieu of a grade mark on lumber as required by DOC PS 20, a certificate of inspection as to species and grade issued by a lumber grading or inspection agency meeting the requirements of DOC PS 20 may be accepted for precut, remanufactured, or rough-sawn lumber, and for sizes larger than 3 inches (76 mm) nominal thickness.

**2303.2.3 Native lumber.** Native lumber shall be acceptable for use in one and two story dwellings, barns, sheds, agricultural and accessory structures. Native

lumber shall also be acceptable for use in other one and two story structures as columns when the design loads are 25% greater than required in Chapter 16; as joists, principal beams, and girders in floor constructions when the design loads are 15% greater than required in Chapter 16; and as other elements when the design loads are as required in Chapter 16.

Each piece of native lumber produced shall be stamped with the name and registration number of the producer in accordance with 780 CMR R4. In addition, all native lumber shall bear an approved mark identifying the species of wood. In lieu of the stamp bearing the name and registration number and species identification, a certification bearing the same information may be provided by the producer for precut or re-manufactured lumber in accordance with 780 CMR R4. When native lumber is used, it shall be subject to the following requirements:

1. Sizing criteria: For lumber, sized in accordance with the DOC PS-20, figures for maximum fiber stress and modulus of elasticity for framing grade No. 2 shall be used in establishing span and spacing characteristics for all structural members.
2. Stress criteria: Lumber which is sized in excess of the dimensions established by the DOC PS-20 for the given nominal size referenced shall be allowed to have a maximum fiber stress increase above that provided in Section 2303.2. 3 Item 1 in proportion to the increased bearing capacity of the cross section as provided in Table 2303.2 or as calculated.

**TABLE 2303.2  
NATIVE LUMBER - ALLOWABLE STRESSES**

Nominal Size	Actual Lumber Size Closest size which does not exceed the size shown)	Multiplier factor based on lumber width	Factor to be added to multiplier factor for lumber oversized in thickness	
	Actual Size (thickness x width)		Thickness increase of 3@ to 2@	Thickness increase of over 2@ to 1@
3 x 8	$2^2 \times 7^2$ $2^2 \times 7^1$ $2^2 \times 8$	1.0 x F <sub>s</sub> 1.07 1.14	+0.10	+0.20
3 x 10	$2^2 \times 9^2$ $2^2 \times 9^{13/4}$ $2^2 \times 10$	1.0 1.05 1.11	+0.10	+0.20
3 x 12	$2^2 \times 11^2$	1.0 1.04	+0.10	+0.20

	$2^2 \times 11^{13/4}$ $2^2 \times 12$	1.09		
3 x 14	$2^2 \times 13^2$ $2^2 \times 13^{13/4}$ $2^2 \times 14$	1.0 1.04 1.07	+0.10	+0.20
4 x 10	$3^2 \times 9^2$ $3^2 \times 9$ $3^2 \times 10$	1.0 1.05 1.11	+0.07	+0.14
4 x 12	$3^2 \times 11^2$ $3^2 \times 11$ $3^2 \times 12$	1.0 1.04 1.09	+0.07	+0.14
4 x 14	$3^2 \times 13^2$ $3^2 \times 13$ $3^2 \times 14$	1.0 1.04 1.08	+0.07	+0.14

**2303.3 Prefabricated wood I-joists.** Prefabricated wood I-joists shall conform to ASTM D 5055.

**2303.4 Structural glued laminated timber.** Glued laminated timbers shall be manufactured and identified as required in AITC A190.1, and ASTM D 3737.

### **2303.5 Wood structural panels.**

**2303.5.1** Wood structural panels, when used structurally (including those used for siding, roof and wall sheathing, subflooring, diaphragms, and built-up members), shall conform to the requirements for its type in DOC PS 1 or DOC PS 2. Each panel or member shall be identified for grade and glue type by the trademarks of an approved testing and grading agency. Wood structural panel components shall be identified by the trademarks of an approved testing and inspection agency indicating conformance with the applicable standard.

**2303.5.2** Wood structural panels when permanently exposed in outdoor applications shall be of exterior type, except that wood structural panel roof sheathing exposed to the outdoors on the underside may be interior type bonded with exterior glue, Exposure 1.

**2303.5.3** In Section 9.2.1.1 of the NDS, the phrase “an approved source” shall be taken to mean “AF&PA ASD Panel Supplement.”

**2303.5.4** In Section 8.3.1 of ASCE 16-95, substitute the following for the 1<sup>st</sup> paragraph: “Panel stiffness and factored reference resistance shall be used in structural - use panel design and shall be in accordance with AF&PA LRFD Panel Supplement - 1996, or shall be determined by test in accordance with DOC PS 1 or DOC PS 2.”

**2303.6 Fiberboard.** Fiberboard for its various uses shall conform to ANSI/AHA A194.1 or ASTM C 208. Fiberboard sheathing, when used structurally, shall be so identified by an approved agency as conforming to ANSI/AHA A194.1 or ASTM C 208.

**2303.6.1 Jointing.** To ensure tight fitting assemblies, edges shall be manufactured with square, ship-lapped, beveled, tongue-and-groove, or U-shaped joints.

**2303.1.5.2 Exposure to weather.** Fiberboard shall not be used for an structural application, such as floor or roof deck or wall sheathing, where it will be exposed to the weather.

**2303.7 Hardboard.** Hardboard siding used structurally shall be identified by an approved agency conforming to AHA A135.6. Hardboard underlayment shall meet the strength requirements of  $\frac{7}{32}$ -inch (5.6 mm) or  $\frac{1}{4}$ -inch (6.4 mm) service class hardboard planed or sanded on one side to a uniform thickness of not less than 0.200 inch (5.1 mm). Pre-finished hardboard paneling shall meet the requirements of AHA A135.5. Other basic hardboard products shall meet the requirements of AHA A135.4. Hardboard products shall be installed in accordance with manufacturer’s recommendations, and shall not be exposed to the weather.

**2303.8 Particleboard.** Particleboard shall conform to ANSI A208.1. Particleboard shall be identified by the grade mark or certificate of inspection issued by an approved agency. Particleboard shall not be utilized for applications other than indicated in this section.

**2303.8.1 Floor underlayment.** Particleboard floor underlayment shall conform to Type PBU of ANSI A208.1. Type PBU underlayment shall not be less than  $\frac{1}{4}$ -inch (6.4 mm) thick and shall be installed in accordance with the installation instructions of the Composite Panel Association.

**2303.9 Preservative-treated wood.** Lumber, timber, plywood, piles and poles supporting permanent structures required by Section 2304.6 to be preservative-treated shall conform to the requirements of the applicable AWWA Standard C1, C2, C3, C4, C9, C14, C15, C16, C22, C23, C24, C28, C31, C33 and M4, for the species, product, preservative and end use. Preservatives shall conform to AWWA P1/P13, P2, P5, P8 and P9.

**2303.9.1 Identification.** Wood that is preservative-treated shall bear the quality mark of an inspection agency that maintains continuing supervision, testing and

inspection over the quality of the preservative-treated wood. Inspection agencies for preservative treated wood shall be listed by an accreditation body that complies with the requirements of the American Lumber Standards Treated Wood Program, or equivalent. The quality mark shall be on a stamp or label affixed to the preservative-treated wood. The quality mark shall include the following information:

1. Identification of treating manufacturer.
2. Type of preservative used.
3. Minimum preservative retention (pef).
4. End use for which the product is treated.
5. AWP standard to which the product was treated.
6. Identity of the accredited inspection agency.

**2303.9.2 Moisture content.** Where preservative-treated wood is used in enclosed locations where drying in service cannot readily occur, such wood shall be at a moisture content of 19 percent or less for lumber and 15 percent or less for wood structural panels before being covered with insulation, interior wall finish, floor covering or other materials.

**2303.10 Fire-retardant-treated wood.** Fire-retardant-treated wood is any wood product which, when impregnated with chemical by a pressure process or other means during manufacture, shall have, when tested in accordance with ASTM E 84, a listed flame spread index of 25 or less and show no evidence of significant progressive combustion when the test is continued for an additional 20-minute period. In addition, the flame front shall not progress more than 10.5 feet (3200 mm) beyond the centerline of the burners at any time during the test.

**2303.10.1 Labeling.** Fire-retardant-treated lumber and wood structural panels shall be labeled. The label shall contain the following items:

1. The identification mark of an approved agency
2. Identification of the treating manufacturer.
3. The name of the fire-retardant treatment.
4. The species of wood treated.
5. Flame spread and smoke-developed index.
6. Method of drying after treatment.
7. Conformance with appropriate standards in accordance with Sections 2303.10.2 through 2303.10.5.
8. For fire-retardant-treated wood exposed to weather, damp or wet locations, include the words "No increase in the listed classification when subjected to the Standard Rain Test" (ASTM D 2898).

**2303.10.2 Strength adjustments.** Design values for untreated lumber and wood structural panels shall be adjusted for fire-retardant-treated wood.



Adjustments to design values shall be based on a method of investigation that takes into consideration the effects of the anticipated temperature and humidity to which the fire-retardant-treated wood will be subjected, the type of treatment and re-drying procedures.

**2303.10.2.1 Wood structural panels.** The effect of treatment and the method of redrying after treatment, and exposure to high temperatures and high humidities on the flexure properties of fire-retardant-treated softwood plywood shall be determined in accordance with ASTM D 5516. The test data developed by ASTM D 5516 shall be used to develop adjustment factors, maximum loads and spans, or both, for untreated plywood design values in accordance with ASTM D 6305. Each manufacturer shall publish the allowable maximum loads and spans for service as floor and roof sheathing for its treatment.

**2303.10.2.2 Lumber.** For each species of wood treated, the effect of the treatment and the method of redrying after treatment and exposure to high temperatures and high humidities on the allowable design properties of fire-retardant-treated lumber shall be determined in accordance with ASTM D 5664. The test data developed by ASTM D 5664 shall be used to develop modification factors for use at or near room temperature and at elevated temperatures and humidity in accordance with an approved method of investigation. Each manufacturer shall publish the modification factors for service at temperatures of not less than 80°F (26.7°C) and for roof framing. The roof framing modification factors shall take into consideration the climatological location.

**2303.10.3 Exposure to weather, damp or wet locations.** Where fire-retardant-treated wood is exposed to weather, or damp or wet locations, it shall be identified as “Exterior” to indicate there is no increase in the listed flame spread index as defined in Section 2303.10 when subjected to ASTM D 2898.

**2303.10.4 Interior applications.** Interior fire-retardant-treated wood shall have moisture content of not over 28 percent when tested in accordance with ASTM D 3201 procedures at 92-percent relative humidity. Interior fire-retardant-treated wood shall be tested in accordance with Section 2303.10.2.1 or 2303.10.2.2. Interior fire-retardant-treated wood designated as Type A shall be tested in accordance with the provisions of this section.

**2303.10.5 Moisture content.** Fire-retardant-treated wood shall be dried to a moisture content of 19 percent or less for lumber and 15 percent or less for wood structural panels before use. For wood kiln dried after treatment (KDAT), the kiln temperatures shall not exceed those used in kiln drying the lumber and plywood submitted for the tests described in Section 2303.10.2.1 for plywood and 2303.10.2.2 for lumber.

**2303.10.6 Type I and II construction applications.** See Section 603.1 for limitations on the use of fire-retardant-treated wood in buildings of Type I or II construction.

**2303.11 Hardwood plywood.** Hardwood and decorative plywood shall be manufactured and identified as required in HPVA HP-1.

**2303.12 Trusses.** Metal plate connected wood trusses shall be manufactured as required by TPI 1. Each manufacturer of trusses using metal plate connectors shall retain an approved agency to make nonscheduled inspections of truss manufacturing and delivery operations. The inspection shall cover all phases of truss operations, including lumber storage, handling, cutting fixtures, presses and rollers, manufacturing, bundling, and banding.

**2303.12.1 Truss design and erection documents.** Truss design and erection documents shall be prepared by a registered design professional experienced in structural engineering. A copy of the final truss design and erection documents shall be provided to the Building Official. Truss design and erection documents shall be provided with the shipments of trusses delivered to the job site. Truss design and erection documents shall include, at a minimum, the information specified below.

1. Slopes, depths, spans, and spacings;
2. Locations and details of joints and field splices;
3. Required bearing widths for each load combination;
4. Design loads (uniformly distributed, concentrated, and moments), including, but not limited to, dead loads, live loads, snow loads (basic, drifting, and sliding), wind loads (external and internal pressures and suctions), seismic loads, impact loads, and hanging loads, individually for top chords, bottom chords, and web members for each load combination;
5. Adjustments to lumber and metal connector plate design values for conditions of use;
6. Reaction forces and directions at each support for each load combination;
7. Metal connector plate types, sizes, thicknesses or gauges, and the dimensioned locations of each metal connector plate;
8. Lumber size, species, and grade for each member;
9. Connection requirements and details for:
  - 15.1. Truss-to-support (truss girders, beams, walls, etc.); and
  - 15.2. Truss ply-to-ply.

10. Calculated deflection ratios and/or maximum deflection values for each load case and load combination;
11. Stresses (bending and/or axial) in each truss member for each load combination. Note members where stress reversals occur.
12. Required truss member bracing to account for member slenderness effects. Detail the types (continuous, "T", "L", etc.), sizes, locations, connections, and end terminations for continuous bracing. Truss member bracing requirements to account for member slenderness effects shall be indicated on the truss erection drawings and the truss design drawings.
13. Required truss member reinforcing and/or bracing for out-of-plane wind loading.

**2303.13 Joist Hangers and similar metal connectors.** The vertical load-bearing capacity, torsional moment capacity, and deflection characteristics of joist hangers and similar connectors shall be determined in accordance with ASTM D 1761, using lumber having a specific gravity of 0.49 or greater, but not greater than 0.55.

**2303.13.1 Vertical load capacity for joist hangers.** The vertical load capacity for the joist hanger shall be determined by testing three joist hanger assemblies as specified in ASTM D 1761. If the ultimate vertical load for any one of the tests varies more than 20 percent from the average ultimate vertical load, at least three additional tests shall be conducted. The allowable vertical load for a normal duration of loading of the joist hanger shall be the lowest value determined from the following:

1. The lowest ultimate vertical load from any test divided by 3 (where three tests are conducted and each ultimate vertical load does not vary more than 20 percent from the average ultimate vertical load).
2. The average ultimate vertical load for all tests divided by 6 (where six or more tests are conducted).
3. The vertical load at which the vertical movement of the joist with respect to the header is 0.125 inch (3.2 mm) in any test.
4. The allowable design load for nails or other fasteners utilized to secure the joist hanger to the wood members.
5. The allowable design load for the wood members forming the connection.

**2303.13.2 Torsional moment capacity for joist hangers.** The torsional moment capacity for the joist hanger shall be determined by testing at least three joist hanger assemblies as specified in ASTM D 1761. The allowable torsional moment for normal duration of loading of the joist hanger shall be the average

torsional moment at which the lateral movement of the top or bottom of the joist with respect to the original position of the joist is 0.125 inch (3.2 mm).

**2303.13.3 Design value modifications for joist hangers.** For species of wood other than that used in the tests, the allowable design values for joist hangers shall be adjusted for specific gravity where failure is controlled by dowel type fasteners (such as nails or bolts), and shall be adjusted for the bearing strength of the wood where failure is controlled by bearing on the wood. Allowable design values for joist hangers that are determined by Item 4 or 5 in Section 2303.13.1 shall be permitted to be modified by the appropriate duration of loading factors as specified in AFPA NDS. Allowable design values determined by Item 1, 2 or 3 in Sections 2303.13.1 shall not be modified by duration of loading factors.

**2303.14 Nails and staples.** Nails and staples shall conform to requirements of ASTM F 1667. Nails used for framing and sheathing connections shall have minimum average bending yield strengths as follows: 80 ksi (551 MPa) for shank diameters larger than 0.177 inch (4.50 mm), but not larger than 0.254 inch (6.45 mm); 90 ksi (620 MPa) for shank diameters larger than 0.142 inch (3.61 mm), but not larger than 0.177 inch (4.50 mm); and 100 ksi (689 MPa) for shank diameters of 0.142 inch (3.61 mm) or less.

## **SECTION 2304 GENERAL CONSTRUCTION REQUIREMENTS**

**2304.1 Framing around flues and chimneys.** Combustible framing shall be a minimum of 2 inches (51 mm), but shall not be less than the distance specified in Sections 2111 and 2113 and the *International Mechanical Code*, from flues, chimneys and fireplaces, and 6 inches (152 mm) away from flue openings.

### **2304.2 Wall sheathing.**

**2304.2.1 Wall sheathing.** Except as provided for in Section 1405 for weather boarding or where stucco construction that complies with Section 2510 is installed, enclosed buildings shall be sheathed with one of the materials of the nominal thickness specified in Table 2304.2.

**2304.2.1.1 Wood structural panel sheathing.** Where wood structural panel sheathing is used as the exposed finish on the exterior of outside walls, it shall have an exterior exposure durability classification. Where wood structural panel sheathing is used on the exterior of outside walls but not as the exposed finish, it shall be of a type manufactured with exterior glue (Exposure 1 or Exterior). Where wood structural panel sheathing is used elsewhere, it shall be of a type manufactured with intermediate or exterior glue.

**[COPY TABLE 2304.2 FROM IBC 2003 TABLE 2304.6 AND CHANGE TABLE NUMBER TO 2304.2] as shown below.**

**TABLE 2304.2  
MINIMUM THICKNESS OF WALL SHEATHING**

SHEATHING TYPE	MINIMUM THICKNESS	MAXIMUM WALL STUD SPACING
Wood boards	$\frac{5}{8}$ inch	24 inches on center
Fiberboard	$\frac{1}{2}$ inch	16 inches on center
Wood structural panel	In accordance with Tables 2308.9.3(2) and 2308.9.3(3)	—
M-S “Exterior Glue” and M-2 “Exterior Glue” Particleboard	In accordance with Tables 2306.4.3 and 2308.9.3(5)	—
Gypsum sheathing	$\frac{1}{2}$ inch	16 inches on center
Gypsum wallboard	$\frac{1}{2}$ inch	24 inches on center
Reinforced cement mortar	1 inch	24 inches on center

For SI: 1 inch = 25.4 mm.

**2304.2.2 Interior paneling.** Softwood wood structural panels used for interior paneling shall conform with the provisions of Chapter 8. Panels shall comply with DOC PS 1 or PS 2. Prefinished hardboard paneling shall meet the requirements of AHA A135.5. Hardwood plywood shall conform to HPVA HP-1.

**2304.3 Structural floor and roof sheathing.** The maximum spans for floor and roof sheathing shall comply with Tables 2304.3(1), 2304.3(2), 2304.3(3), 2304.3(4) or 2304.3(5), as applicable. Wood structural panel roof sheathing shall be bonded by exterior glue.

**[COPY TABLES 2304.3(1) AND 2304.3(2) FROM IBC 2003 TABLES 2304.7(1) AND 2304.7(2), RESPECTIVELY, AND CHANGE TABLE NUMBERS AS SHOWN BELOW].**

**TABLE 2304.7(1)  
ALLOWABLE SPANS FOR LUMBER FLOOR AND ROOF SHEATHING<sup>a,b</sup>**

SPAN (inches)	MINIMUM NET THICKNESS (Inches) OF LUMBER PLACED			
	Perpendicular to supports		Diagonally to supports	
	Surfaced dry <sup>c</sup>	Surfaced unseasoned	Surfaced dry <sup>c</sup>	Surfaced unseasoned
<b>Floors</b>				
24	$\frac{3}{4}$	$\frac{25}{32}$	$\frac{3}{4}$	$\frac{25}{32}$
16	$\frac{5}{8}$	$\frac{11}{16}$	$\frac{5}{8}$	$\frac{11}{16}$
<b>Roofs</b>				
24	$\frac{5}{8}$	$\frac{11}{16}$	$\frac{3}{4}$	$\frac{25}{32}$

For SI: 1 inch = 25.4 mm.

~~a. Installation details shall conform to Sections 2304.6.1 and 2304.6.2 for floor and roof sheathing, respectively.~~

~~b. Floor or roof sheathing conforming with this table shall be deemed to meet the design criteria of Section 2304.6.~~

c. Maximum 19-percent moisture content.

**TABLE 2304.7(2)  
SHEATHING LUMBER, MINIMUM GRADE REQUIREMENTS: BOARD GRADE**

SOLID FLOOR OR ROOF SHEATHING	SPACED ROOF SHEATHING	GRADING RULES
Utility	Standard	NLGA, WCLIB, WWPA
4 common or utility	3 common or standard	NLGA, WCLIB, WWPA, NSLB or NELMA
No. 3	No. 2	SPIB
Merchantable	Construction common	RIS

[COPY TABLE 2304.3(3) FROM IBC 2003 TABLE 2304.7(3), CHANGE TABLE NUMBER, AND DELETE FOOTNOTE WHERE INDICATED] as shown below.

TABLE 2304.7(3)  
ALLOWABLE SPANS AND LOADS FOR WOOD STRUCTURAL PANEL SHEATHING AND  
SINGLE-FLOOR GRADES CONTINUOUS OVER TWO OR MORE SPANS WITH  
STRENGTH AXIS PERPENDICULAR TO SUPPORTS<sup>a</sup>

SHEATHING GRADES		ROOF <sup>c</sup>				FLOOR <sup>d</sup>
Panel span rating roof/floor span	Panel thickness (inches)	Maximum span (inches)		Load <sup>e</sup> (psf)		Maximum span (inches)
		With edge support <sup>f</sup>	Without edge support	Total load	Live load	
12/0	5/16	12	12	40	30	0
16/0	5/16, 3/8	16	16	40	30	0
20/0	5/16, 3/8	20	20	40	30	0
24/0	3/8, 7/16, 1/2	24	20 <sup>g</sup>	40	30	0
24/16	7/16, 1/2	24	24	50	40	16
32/16	15/32, 1/2, 5/8	32	28	40	30	16 <sup>h</sup>
40/20	19/32, 5/8, 3/4, 7/8	40	32	40	30	20 <sup>h,i</sup>
48/24	23/32, 3/4, 7/8	48	36	45	35	24
54/32	7/8, 1	54	40	45	35	32
60/32	7/8, 1 1/8	60	48	45	35	32
SINGLE FLOOR GRADES		ROOF <sup>c</sup>				FLOOR <sup>d</sup>
Panel span rating	Panel thickness (inches)	Maximum span (inches)		Load <sup>e</sup> (psf)		Maximum span (inches)
		With edge support <sup>f</sup>	Without edge support	Total load	Live load	
16 o.c.	1/2, 19/32, 5/8	24	24	50	40	16 <sup>h</sup>
20 o.c.	19/32, 5/8, 3/4	32	32	40	30	20 <sup>h,i</sup>
24 o.c.	23/32, 3/4	48	36	35	25	24
32 o.c.	7/8, 1	48	40	50	40	32
48 o.c.	1 3/32, 1 1/8	60	48	50	40	48

For SI: 1 inch = 25.4 mm, 1 pound per square foot = 0.0479 kN/m<sup>2</sup>.

a. Applies to panels 24 inches or wider.

~~b. Floor and roof sheathing conforming with this table shall be deemed to meet the design criteria of Section 2304.7.~~

c. Uniform load deflection limitations 1/180 of span under live load plus dead load, 1/240 under live load only.

d. Panel edges shall have approved tongue-and-groove joints or shall be supported with blocking unless 1/4-inch minimum thickness underlayment or 1 1/2 inches of approved cellular or lightweight concrete is placed over the subfloor, or finish floor is 3/4-inch wood strip. Allowable uniform load based on deflection of 1/360 of span is 100 pounds per square foot except the span rating of 48 inches on center is based on a total load of 65 pounds per square foot.

e. Allowable load at maximum span.

f. Tongue-and-groove edges, panel edge clips (one midway between each support, except two equally spaced between supports 48 inches on center), lumber blocking or other. Only lumber blocking shall satisfy blocked diaphragm requirements.

g. For 1/2-inch panel, maximum span shall be 24 inches.

h. Span is permitted to be 24 inches on center where 3/4-inch wood strip flooring is installed at right angles to joist.

i. Span is permitted to be 24 inches on center for floors where 1 1/2 inches of cellular or lightweight concrete is applied over the panels.



**TABLE 2304.7(4)**  
**ALLOWABLE SPAN FOR WOOD STRUCTURAL PANEL COMBINATION SUBFLOOR-UNDERLAYMENT (SINGLE FLOOR)<sup>a,b</sup>**  
**(Panels Continuous Over Two or More Spans and Strength Axis Perpendicular to Supports)**

IDENTIFICATION	MAXIMUM SPACING OF JOISTS (Inches)				
	16	20	24	32	48
Species group <sup>c</sup>	Thickness (Inches)				
1	1/2	5/8	3/4	—	—
2, 3	5/8	3/4	7/8	—	—
4	3/4	7/8	1	—	—
Single floor span rating <sup>d</sup>	16 o.c.	20 o.c.	24 o.c.	32 o.c.	48 o.c.

For SI: 1 inch = 25.4 mm, 1 pound per square foot = 0.0479 kN/m<sup>2</sup>.

a. Spans limited to value shown because of possible effects of concentrated loads. Allowable uniform loads based on deflection of 1/360 of span is 100 pounds per square foot except allowable total uniform load for 1 1/8-inch wood structural panels over joists spaced 48 inches on center is 65 pounds per square foot. Panel edges shall have approved tongue-and-groove joints or shall be supported with blocking, unless 1/4-inch minimum thickness underlayment or 1 1/2 inches of approved cellular or lightweight concrete is placed over the subfloor, or finish floor is 3/4-inch wood strip.

~~b. Floor panels conforming with this table shall be deemed to meet the design criteria of Section 2304.7.~~

c. Applicable to all grades of sanded exterior-type plywood. See DOC PS 1 for plywood species groups.

d. Applicable to Underlayment grade, C-C (Plugged) plywood, and Single Floor grade wood structural panels.

**[COPY TABLES 2304.3(4) AND (5) FROM IBC 2003 TABLE 2304.7(4) AND (5), CHANGE TABLE NUMBER, AND DELETE FOOTNOTES WHERE INDICATED AS SHOWN BELOW].**

**TABLE 2304.7(5)**  
**ALLOWABLE LOAD (PSF) FOR WOOD STRUCTURAL PANEL ROOF SHEATHING CONTINUOUS OVER TWO OR MORE SPANS AND STRENGTH AXIS PARALLEL TO SUPPORTS**  
**(Plywood Structural Panels Are Five-Ply, Five-Layer Unless Otherwise Noted)<sup>a,b</sup>**

PANEL GRADE	THICKNESS (inch)	MAXIMUM SPAN (inches)	LOAD AT MAXIMUM SPAN (psf)	
			Live	Total
Structural I sheathing	7/16	24	20	30
	15/32	24	35 <sup>c</sup>	45 <sup>c</sup>
	1/2	24	40 <sup>c</sup>	50 <sup>c</sup>
	19/32, 5/8	24	70	80
	23/32, 3/4	24	90	100
Sheathing, other grades covered in DOC PS 1 or DOC PS 2	7/16	16	40	50
	15/32	24	20	25
	1/2	24	25	30
	19/32	24	40 <sup>c</sup>	50 <sup>c</sup>
	5/8	24	45 <sup>c</sup>	55 <sup>c</sup>
	23/32, 3/4	24	60 <sup>c</sup>	65 <sup>c</sup>

For SI: 1 inch = 25.4 mm, 1 pound per square foot = 0.0479 kN/m<sup>2</sup>.

~~a. Roof sheathing conforming with this table shall be deemed to meet the design criteria of Section 2304.7.~~

b. Uniform load deflection limitations 1/180 of span under live load plus dead load, 1/240 under live load only. Edges shall be blocked with lumber or other approved type of edge supports.

c. For composite and four-ply plywood structural panel, load shall be reduced by 15 pounds per square foot.

**2304.4 Mechanically laminated floors and decks.** A laminated lumber floor or deck built up of wood members set on edge, when meeting the following requirements, is permitted to be designed as a solid floor or roof deck of the same thickness, and continuous spans are permitted to be designed on the basis of the full cross section using the simple span moment coefficient.

Nail lengths shall not be less than two and one-half times the net thickness of each lamination. Where deck supports are 4 feet (1219 mm) on center or less, side nails shall be spaced not more than 30 inches (762 mm) on center alternately near top and bottom edges, and staggered one-third of the spacing in adjacent laminations. Where supports are spaced more than 4 feet (1219 mm) on center, side nails shall be spaced not more than 18 inches (457 mm) on center alternately near top and bottom edges, and staggered one-third of the spacing in adjacent laminations. Two side nails shall be used at each end of butt-jointed pieces.

Laminations shall be toe-nailed to supports with 20d or larger common nails. Where the supports are 4 feet (1219 mm) on center or less, alternate laminations shall be toe-nailed to alternate supports; where supports are spaced more than 4 feet (1219 mm) on center, alternate laminations shall be toe-nailed to every support. A single-span deck shall have all laminations full length. A continuous deck of two spans shall not have more than every fourth lamination spliced within quarter points adjoining supports. Joints shall be closely butted over supports or staggered across the deck but within the adjoining quarter spans. No lamination shall be spliced more than twice in any span.

#### **2304.5 Connections and fasteners.**

**2304.5.1 Nails.** The number and size of nails connecting wood members shall not be less than that set forth in Table 2304.5.

**2304.5.2 Sheathing fasteners.** Sheathing nails or similar fasteners shall be driven so that their head or crown is flush with the surface of the sheathing.

**2304.5.3 Fasteners in preservative-treated and fire-retardant-treated wood.** Fasteners for preservative-treated and fire-retardant-treated wood shall be of hot-dipped zinc coated galvanized steel, stainless steel, silicon bronze, or copper.

**2304.5.4 Columns and posts.** Wood columns and posts shall be framed to provide full end bearing. Alternatively, column-and-post end connections shall be designed to resist the full compressive loads. Column and post end connections shall be fastened to resist lateral and net induced uplift forces.



**[COPY TABLE 2304.5 FROM IBC 2003 TABLE 2304.9(1) AND CHANGE TABLE NUMBER AS SHOWN BELOW].**

**TABLE 2304.5**  
**FASTENING SCHEDULE**

CONNECTION	FASTENING <sup>a,m</sup>	LOCATION
1. Joist to sill or girder	3 - 8d common 3 - 3" x 0.131" nails 3 - 3" 14 gage staples	toenail
2. Bridging to joist	2 - 8d common 2 - 3" x 0.131" nails 2 - 3" 14 gage staples	toenail each end
3. 1" x 6" subfloor or less to each joist	2 - 8d common	face nail
4. Wider than 1" x 6" subfloor to each joist	3 - 8d common	face nail
5. 2" subfloor to joist or girder	2 - 16d common	blind and face nail
6. Sole plate to joist or blocking	16d at 16" o.c. 3" x 0.131" nails at 8" o.c. 3" 14 gage staples at 12" o.c.	typical face nail
Sole plate to joist or blocking at braced wall panel	3 - 16d at 16" 4 - 3" x 0.131" nails at 16" 4 - 3" 14 gage staples per 16"	braced wall panels
7. Top plate to stud	2 - 16d common 3 - 3" x 0.131" nails 3 - 3" 14 gage staples	end nail
8. Stud to sole plate	4 - 8d common 4 - 3" x 0.131" nails 3 - 3" 14 gage staples  2 - 16d common 3 - 3" x 0.131" nails 3 - 3" 14 gage staples	toenail  end nail
9. Double studs	16d at 24" o.c. 3" x 0.131" nail at 8" o.c. 3" 14 gage staple at 8" o.c.	face nail
10. Double top plates	16d at 16" o.c. 3" x 0.131" nail at 12" o.c. 3" 14 gage staple at 12" o.c.	typical face nail
Double top plates	8-16d common 12 - 3" x 0.131" nails 12 - 3" 14 gage staples typical face nail	lap splice
11. Blocking between joists or rafters to top plate	3 - 8d common 3 - 3" x 0.131" nails 3 - 3" 14 gage staples	toenail
12. Rim joist to top plate	8d at 6" (152 mm) o.c. 3" x 0.131" nail at 6" o.c. 3" 14 gage staple at 6" o.c.	toenail
13. Top plates, laps and intersections	2 - 16d common 3 - 3" x 0.131" nails 3 - 3" 14 gage staples	face nail
14. Continuous header, two pieces	16d common	16" o.c. along edge
15. Ceiling joists to plate	3 - 8d common 5 - 3" x 0.131" nails 5 - 3" 14 gage staples	toenail
16. Continuous header to stud	4 - 8d common	toenail

(continued)

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TABLE 2304.9-1—continued  
FASTENING SCHEDULE

CONNECTION	FASTENING <sup>a,m</sup>	LOCATION
17. Ceiling joists, laps over partitions (see Section 2308.10.4.1, Table 2308.10.4.1)	3 - 16d common minimum, Table 2308.10.4.1 4 - 3" × 0.131" nails 4 - 3" 14 gage staples	face nail
18. Ceiling joists to parallel rafters (see Section 2308.10.4.1, Table 2308.10.4.1)	3 - 16d common minimum, Table 2308.10.4.1 4 - 3" × 0.131" nails 4 - 3" 14 gage staples	face nail
19. Rafter to plate (see Section 2308.10.1, Table 2308.10.1)	3 - 8d common 3 - 3" × 0.131" nails 3 - 3" 14 gage staples	toenail
20. 1" diagonal brace to each stud and plate	2 - 8d common 2 - 3" × 0.131" nails 2 - 3" 14 gage staples face nail	face nail
21. 1" × 8" sheathing to each bearing wall	2 - 8d common	face nail
22. Wider than 1" × 8" sheathing to each bearing	3 - 8d common	face nail
23. Built-up corner studs	16d common 3" × 0.131" nails 3" 14 gage staples	24" o.c. 16" o.c. 16" o.c.
24. Built-up girder and beams	20d common 32" o.c. 3" × 0.131" nail at 24" o.c. 3" 14 gage staple at 24" o.c.  2 - 20d common 3 - 3" × 0.131" nails 3 - 3" 14 gage staples	face nail at top and bottom staggered on opposite sides  face nail at ends and at each splice
25. 2" planks	16d common	at each bearing
26. Collar tie to rafter	3 - 10d common 4 - 3" × 0.131" nails 4 - 3" 14 gage staples face nail	face nail
27. Jack rafter to hip	3 - 10d common 4 - 3" × 0.131" nails 4 - 3" 14 gage staples  2 - 16d common 3 - 3" × 0.131" nails 3 - 3" 14 gage staples	toenail  face nail
28. Roof rafter to 2-by ridge beam	2 - 16d common 3 - 3" × 0.131" nails 3 - 3" 14 gage staples  2 - 16d common 3 - 3" × 0.131" nails 3 - 3" 14 gage staples	toenail  face nail
29. Joist to band joist	3 - 16d common 5 - 3" × 0.131" nails 5 - 3" 14 gage staples	face nail

(continued)

5  
**TABLE 2304.6.1—continued**  
**FASTENING SCHEDULE**

CONNECTION	FASTENING <sup>a,m</sup>		LOCATION
30. Ledger strip	3 - 16d common 4 - 3" × 0.131" nails 4 - 3" 14 gage staples		face nail
31. Wood structural panels and particleboard: <sup>b</sup> Subfloor, roof and wall sheathing (to framing):	1/2" and less	6d <sup>c,l</sup> 2 3/8" × 0.113" nail <sup>n</sup> 1 3/4" 16 gage <sup>o</sup> 8d <sup>d</sup> or 6d <sup>e</sup> 2 3/8" × 0.113" nail <sup>p</sup> 2" 16 gage <sup>p</sup>	
	19/32" to 3/4"		
	7/8" to 1"	8d <sup>e</sup>	
Single Floor (combination subfloor-underlayment to framing):	1 1/8" to 1 1/4"	10d <sup>d</sup> or 8d <sup>e</sup>	
	3/4" and less	6d <sup>e</sup>	
	7/8" to 1"	8d <sup>e</sup>	
	1 1/8" to 1 1/4"	10d <sup>d</sup> or 8d <sup>e</sup>	
32. Panel siding (to framing)	1/2" or less	6d <sup>f</sup> 8d <sup>f</sup>	
33. Fiberboard sheathing: <sup>g</sup>	1/2"	No. 11 gage roofing nail <sup>h</sup> 6d common nail No. 16 gage staple <sup>i</sup>	
	25/32"	No. 11 gage roofing nail <sup>h</sup> 8d common nail No. 16 gage staple <sup>i</sup>	
34. Interior paneling	1/4" 3/8"		4d <sup>j</sup> 6d <sup>k</sup>

For SI: 1 inch = 25.4 mm.

- a. Common or box nails are permitted to be used except where otherwise stated.
- b. Nails spaced at 6 inches on center at edges, 12 inches at intermediate supports except 6 inches at supports where spans are 48 inches or more. For nailing of wood structural panel and particleboard diaphragms and shear walls, refer to Section 2305. Nails for wall sheathing are permitted to be common, box or casing.
- c. Common or deformed shank.
- d. Common.
- e. Deformed shank.
- f. Corrosion-resistant siding or casing nail.
- g. Fasteners spaced 3 inches on center at exterior edges and 6 inches on center at intermediate supports.
- h. Corrosion-resistant roofing nails with 7/16-inch-diameter head and 1 1/2-inch length for 1/2-inch sheathing and 1 3/4-inch length for 25/32-inch sheathing.
- i. Corrosion-resistant staples with nominal 7/16-inch crown and 1 1/4-inch length for 1/2-inch sheathing and 1 1/2-inch length for 25/32-inch sheathing. Panel supports at 16 inches (20 inches if strength axis in the long direction of the panel, unless otherwise marked).
- j. Casing or finish nails spaced 6 inches on panel edges, 12 inches at intermediate supports.
- k. Panel supports at 24 inches. Casing or finish nails spaced 6 inches on panel edges, 12 inches at intermediate supports.
- l. For roof sheathing applications, 8d nails are the minimum required for wood structural panels.
- m. Staples shall have a minimum crown width of 7/16 inch.
- n. For roof sheathing applications, fasteners spaced 4 inches on center at edges, 8 inches at intermediate supports.
- o. Fasteners spaced 4 inches on center at edges, 8 inches at intermediate supports for subfloor and wall sheathing and 3 inches on center at edges, 6 inches at intermediate supports for roof sheathing.
- p. Fasteners spaced 4 inches on center at edges, 8 inches at intermediate supports.

## 2304.6 Protection against decay and termites.

**2304.6.1 General.** Where required by this section, protection from decay and termites shall be provided by the use of naturally durable or preservative-treated wood.

**2304.6.2 Wood used above ground.** Wood installed above ground in the locations specified in Sections 2304.6.2.1 through 2304.6.2.6 shall be naturally durable wood or preservative-treated wood that uses water-borne preservatives, and shall be treated in accordance with AWPA C2 or C9 or applicable AWPA standards for above-ground use.

**2304.6.2.1 Joists, girders, and subflooring.** Where wood joists or the bottom of a wood structural floor without joists are closer than 18 inches (457 mm), or wood girders are closer than 12 inches (305 mm), to the exposed ground in crawl spaces or unexcavated areas located within the perimeter of the building foundation, the floor assembly (including posts, girders, joists and subfloor) shall be of naturally durable or preservative-treated wood.

**2304.6.2.2 Framing.** Wood framing members, including wood sheathing, which rest on exterior foundation walls and are less than 8 inches (203 mm) from exposed earth shall be of naturally durable or preservative-treated wood. Wood framing members and furring strips attached directly to the interior of exterior masonry or concrete walls below grade shall be of approved naturally durable or preservative-treated wood.

**2304.6.2.3 Sleepers and sills.** Sleepers and sills on a concrete or masonry slab that is in direct contact with earth shall be of naturally durable or preservative-treated wood.

**2304.6.2.4 Girder ends.** The ends of wood girders entering exterior masonry or concrete walls shall be provided with a  $\frac{1}{2}$ -inch (12.7 mm) air space on top, sides and end, unless naturally durable or preservative-treated wood is used.

**2304.6.2.5 Wood siding.** Clearance between wood siding and earth on the exterior of a building shall not be less than 6 inches (152 mm) except where siding, sheathing and wall framing are of naturally durable or preservative-treated wood.

**2304.6.2.6 Posts or columns.** Posts or columns supporting permanent structures and supported by a concrete or masonry slab or footing that is in direct contact with the earth shall be of naturally durable or preservative-treated wood.

**Exceptions:**

1. Posts or columns that are either exposed to the weather or located in basements or cellars, supported by concrete piers or metal pedestals projected at least 1 inch (25 mm) above the slab or deck and 6 inches (152 mm) above exposed earth, and are separated there from by an impervious moisture barrier.
2. Posts or columns in enclosed crawl spaces or unexcavated areas located within the periphery of the building, supported by a concrete pier or metal pedestal at a height greater than 8 inches (203 mm) from exposed ground, and are separated there from by an impervious moisture barrier.

**2304.6.3 Laminated timbers.** The portions of glued laminated timbers that form the structural supports of a building or other structure and are exposed to weather and not properly protected by a roof, eave or similar covering shall be pressure treated with preservative, or be manufactured from naturally durable or preservative treated wood.

**2304.6.4 Wood in contact with the ground or fresh water.** Wood in contact with the ground (exposed earth) that supports permanent structures shall be of naturally durable (species for both decay and termite resistant) or preservative-treated wood using water-borne preservatives and shall be treated in accordance with AWWA C2, C9 or other applicable AWWA standard for soil or fresh water contact, where used in the locations specified in Sections 2304.6.4.1 and 2304.6.4.2.

**Exception:** Untreated wood is permitted where such wood is continuously and entirely below the ground water level or submerged in fresh water.

**2304.6.4.1 Posts or columns.** Posts and columns supporting permanent structures that are embedded in concrete in direct contact with the earth or embedded in concrete exposed to the weather, or in direct contact with the earth, shall be of preservative-treated wood.

**2304.6.4.2 Wood structural members.** Wood structural members that support moisture-permeable floors or roofs that are exposed to the weather, such as concrete or masonry slabs, shall be of naturally durable or preservative-treated wood unless separated from such floors or roofs by an impervious moisture barrier.

**2304.6.5 Supporting member for permanent appurtenances.** Naturally durable or preservative-treated wood shall be utilized for those portions of wood members that form the structural supports of buildings, balconies, porches, or similar permanent building appurtenances where such members are exposed to the weather without adequate protection from a roof, eave, overhead or other covering to prevent moisture or water accumulation on the surface or at joints between members.

**2304.6.6 Wood used in retaining walls and cribs.** Wood installed in retaining or crib walls shall be of preservative-treated wood treated in accordance with AWWA C2 or C9 for soil and fresh water contact.

**2304.7 Wood supporting masonry or concrete.** Wood members shall not be used to permanently support the dead load of any masonry or concrete.

***Exceptions:***

1. Masonry or concrete nonstructural floor or roof surfacing not more than 4 inches (102 mm) thick is permitted to be supported by wood members.

2. Any structure is permitted to rest upon wood piles constructed in accordance with the requirements of Chapter 18.
3. Glass unit masonry having an installed weight of 20 pounds per square foot (0.96 kN/m<sup>2</sup>) or less is permitted to be installed in accordance with the provisions of Chapter 21. The wood construction supporting the glass unit masonry shall be designed to support the additional weight of the glass unit masonry plus any other loads and designed to limit deflection and shrinkage to the smaller of  $\frac{1}{600}$  of the span of the supporting members or 0.3 inches.

**2304.8 Wood construction in foundations.** Wood construction is not permitted for basement walls and foundations of buildings, except for piles and poles.

**2304.9 Shrinkage.** Consideration shall be given in design to the possible effect of cross-grain dimensional changes considered vertically which may occur in lumber fabricated in a green condition.

**2304.9.1.** Wood walls and bearing partitions shall not support more than two floors and a roof unless an analysis satisfactory to the building official shows that shrinkage of the wood framing will not have adverse effects on the structure or any plumbing, electrical or mechanical systems, or other equipment installed therein due to excessive shrinkage or differential movements caused by shrinkage. The analysis shall also show that the roof drainage system and the foregoing systems or equipment will not be adversely affected or, as an alternate, such systems shall be designed to accommodate the differential shrinkage or movements.

## **SECTION 2305 GENERAL DESIGN REQUIREMENTS FOR LATERAL-FORCE-RESISTING SYSTEMS**

**[Section 2305 is based on IBC 2003. Make IBC 2004 Supplement revisions (except for 2305.3.10). Then, revise the text as shown below].**

**2305.1 General.** Structures using wood shear walls and diaphragms to resist wind, seismic and other lateral loads, shall be designed and constructed in accordance with the provisions of this section.

***2305.1.1 Framing. Boundary elements shall be provided to transmit tension and compression forces. Perimeter members at openings shall be provided and shall be detailed to distribute the shearing stresses. Diaphragm and shear wall sheathing shall not be used to splice boundary elements. Diaphragm chords and collectors shall be placed in, or tangent to, the plane of the diaphragm framing unless it can be demonstrated that the moments, shears, and deformations, considering eccentricities resulting from other configurations can be tolerated without exceeding the adjusted resistance and drift limits.***

**2305.1.1.1 Framing members.** *Framing members shall be at least 2-inch (51 mm) nominal width. In general, adjoining panel edges shall bear and be attached to the framing members and butt along their center lines. Nails shall be placed not less than  $\frac{3}{8}$  inch (9.5 mm) from the panel edge, not more than 12 inches (305 mm) apart along intermediate supports, and 6 inches (152 mm) along panel edge bearings, and shall be firmly driven into the framing members.*

**2305.1.3 Openings in shear panels.** Openings in shear panels that materially affect their strength shall be fully detailed on the plans, and shall have their edges adequately reinforced to transfer all shearing stresses.

**2305.1.4 Shear panel connections.** *Positive connections and anchorages, capable of resisting the design forces, shall be provided between the shear panel and the attached components. Toenails shall not be used to transfer lateral forces in excess of 150 pounds per foot (2189 N/m) from diaphragms to shear walls, drag struts (collectors) or other elements, or from shear walls to other elements.*

**2305.1.5 Wood members resisting horizontal seismic forces contributed by masonry and concrete.** Wood shear walls, diaphragms, horizontal trusses and other members shall not be used to resist horizontal seismic forces contributed by masonry or concrete construction in structures over one story in height.

**Exceptions:**

1. Wood floor and roof members are permitted to be used in horizontal trusses and diaphragms to resist horizontal seismic forces contributed by masonry or concrete construction (including those due to masonry veneer, fireplaces, and chimneys) provided such forces do not result in torsional force distribution through the truss or diaphragm.
2. ***Wood structural panel sheathed shear walls are permitted to be used to provide resistance to seismic forces contributed by masonry or concrete construction in two-, three-, and four story structures of masonry or concrete construction, provided the following requirements are met:***
  - 2.1. Story-to-story wall heights shall not exceed 12 feet (3658 mm).
  - 2.2. Diaphragms shall not be designed to transmit lateral forces by rotation. Diaphragms shall not cantilever past the outermost supporting shear wall.
  - 2.3. **Combined deflections of diaphragms and shear walls shall not permit story drift of supported masonry or concrete walls to exceed the limit of Table 9.5.2.8 of ASCE 7.**
  - 2.4. Wood structural panel sheathing in diaphragms shall have unsupported edges blocked. Wood structural panel sheathing for all ~~both~~ stories of shear walls shall have unsupported edges blocked and, for the lowest ~~lower~~ story, shall have a minimum thickness of  $\frac{15}{32}$  inch (11.9 mm).



2.5. There shall be no out-of-plane horizontal offsets between the first and second stories of wood structural panel shear walls.

2.6. Concrete and masonry shear walls shall be continuous to the foundation.

#### 2305.1.6 [per IBC 2004 Supplement].

### 2305.2 Design of wood diaphragms.

**2305.2.1 General.** Wood diaphragms are permitted to be used to resist horizontal forces provided the deflection in the plane of the diaphragm, as determined by calculations, tests, or analogies drawn therefrom, does not exceed the permissible deflection of attached distributing or resisting elements. Connections shall extend into the diaphragm a sufficient distance to develop the force transferred into the diaphragm.

**2305.2.2 Deflection.** Permissible deflection shall be that deflection up to which the diaphragm and any attached distributing or resisting element will maintain its structural integrity under design load conditions, such that the resisting element will continue to support design loads without danger to occupants of the structure. Calculations for diaphragm deflection shall account for the usual bending and shear components as well as any other factors, such as nail deformation, which will contribute to deflection.

The deflection ( $\Delta$ ) of a blocked wood structural panel diaphragm uniformly nailed throughout is permitted to be calculated by the use of the following formula. If not uniformly nailed, the constant 0.188 (For SI: 1/1627) in the third term must be modified accordingly.

$$\Delta = \frac{5vL^3}{8EAb} + \frac{vL}{4Gt} + 0.188Le_n + \frac{\sum(\Delta_c X)}{2b} \quad \text{(Equation 23-1)}$$

$$\text{For SI: } \Delta = \frac{0.052vL^3}{EAb} + \frac{vL}{4Gt} + \frac{Le_n}{1627} + \frac{\sum(\Delta_c X)}{2b}$$

where:

$A$  = Area of chord cross section, in square inches ( $\text{mm}^2$ ).

$b$  = Diaphragm width, in feet (mm).

$E$  = Elastic modulus of chords, in pounds per square inch ( $\text{N/mm}^2$ ).

$e_n$  = Nail deformation, in inches (mm).

$G$  = Modulus of rigidity of wood structural panel, in pounds per square inch ( $\text{N/mm}^2$ ).

$L$  = Diaphragm length, in feet (mm).

$t$  = Effective thickness of wood structural panel for shear, in inches (mm).



- $v$  = Maximum shear due to design loads in the direction under consideration, in pounds per lineal foot (N/mm).
- $\Delta$  = The calculated deflection, in inches (mm).
- $\Sigma(\Delta_c X)$  = *Sum of individual chord-splice slip values on both sides of the diaphragm, each multiplied by its distance to the nearest support.*

**[INSERT TABLES 2305.2.2(1) AND (2) PER IBC 2004 SUPPLEMENT].**

**2305.2.3 Diaphragm aspect ratios.** Size and shape of diaphragms shall be limited as set forth in Table 2305.2.3.

**TABLE 2305.2.3  
MAXIMUM DIAPHRAGM DIMENSION RATIOS HORIZONTAL AND SLOPED  
DIAPHRAGM**

TYPE	MAXIMUM LENGTH - WIDTH RATIO
Wood structural panel, nailed all edges	4:1
Wood structural panel, blocking omitted at intermediate joints	3:1
Diagonal sheathing, single	3:1
Diagonal sheathing, double	4:1

**2305.2.4 Construction.** *Shear panels shall be constructed of wood structural panels, manufactured with exterior glue, not less than 4 by 8 feet (1219 mm by 2438 mm), except at boundaries and changes in framing. Boundary elements shall be connected at corners. Wood structural panel thickness for horizontal diaphragms shall not be less than set forth in Clause 2301.2.1(2) or 2301.2.2(5) for corresponding joist spacing and loads, except that 1/4-inch (6.4 mm) is permitted to be used where perpendicular loads permit. Sheet-type sheathing shall be arranged so that the width of a sheet in a shear wall shall not be less than 2 feet (610 mm).*

**2305.2.5 Rigid diaphragms.** *Design of structures with rigid diaphragms shall conform to the structure configuration requirements and the horizontal shear distribution requirements of Section 1615.*

Open front structures with rigid wood diaphragms resulting in torsional force distribution are permitted provided the length,  $l$ , of the diaphragm normal to the open side does not exceed 25 feet (7620 mm), the diaphragm sheathing conforms to Section 2305.2.4, and the  $l/w$  ratio (as shown in Figure 2305.2.5(1)) is less than 1.0 for one-story structures or 0.67 for structures over one story in height.

**Exception:** Where calculations show that diaphragm deflections can be tolerated, the length,  $l$ , normal to the open end is permitted to be increased to a  $l/w$  ratio not greater than 1.5 where sheathed in conformance with Section 2305.2.4 or to 1.0 where sheathed in conformance with Section 2306.3.4 or 2306.3.5.

Rigid wood diaphragms are permitted to cantilever past the outermost supporting shear wall (or other vertical-resisting element) a length,  $l$ , of not more than 25 feet (7620 mm) or two-thirds of the diaphragm width,  $w$ , whichever is the smaller. Figure 2305.2.5(2) illustrates the dimensions of  $l$  and  $w$  for a cantilevered diaphragm.

Structures with rigid wood diaphragms having a torsional irregularity in accordance with Table 1616.5.1, Item 1, shall meet the following requirements: The  $l/w$  ratio shall not exceed 1.0 for one-story structures or 0.67 for structures over one story in height, where  $l$  is the dimension parallel to the load direction for which the irregularity exists.

**Exception:** Where calculations demonstrate that the diaphragm deflections can be tolerated, the width is permitted to be increased and the  $l/w$  ratio is permitted to be increased to 1.5 where sheathed in conformance with Section 2305.2.4 or 1.0 where sheathed in conformance with Section 2306.3.4 or 2306.3.5.

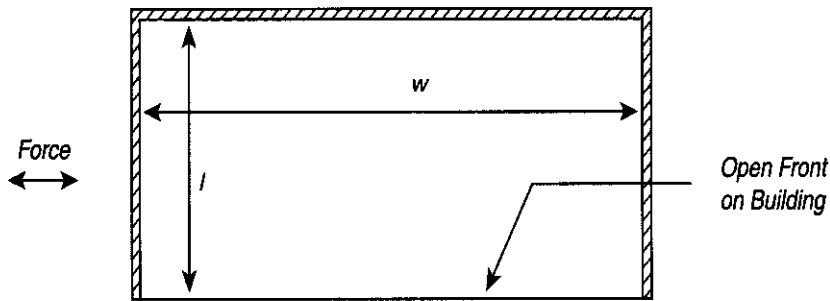


FIGURE 2305.2.5(1)  
DIAPHRAGM LENGTH AND WIDTH FOR PLAN VIEW OF OPEN FRONT BUILDING

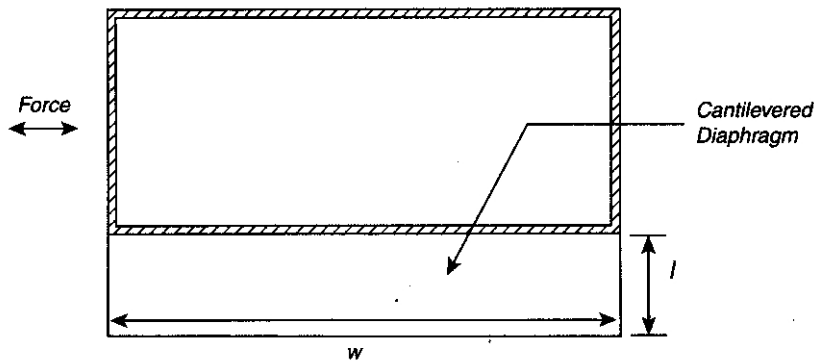


FIGURE 2305.2.5(2)  
DIAPHRAGM LENGTH AND WIDTH FOR PLAN VIEW OF CANTILEVERED DIAPHRAGM

### 2305.3 Design of wood shear walls.

**2305.3.1 General.** Wood shear walls are permitted to resist horizontal forces in vertical distributing or resisting elements, provided the deflection in the plane of the shear wall, as determined by calculations, tests, or analogies drawn therefrom, does not exceed the more restrictive of the permissible deflection of attached distributing or resisting elements or the drift limits of Section 9.5.2.8 OF ASCE 7. Shear wall sheathing other than wood structural panels shall not be permitted.

**Exception:** Buildings of conventional light-frame wood construction may have shear wall sheathing of diagonal wood sheathing, metal lath and plaster, gypsum lath, gypsum sheathing, gypsum board, hardboard, or particleboard providing all of the following conditions are met:

1. The building shall not be more than 35 feet in height.
2. The shear walls shall not provide lateral load resistance for more than three framed levels (floors or roof). In this context, a pitched

**roof shall be considered a “level.” Where attics are habitable, the pitched roof and attic floor shall be considered separate levels.**

- 3. The location of the shear walls shall be limited to exterior walls, fire walls or fire partitions.**
- 4. The building is not in Seismic Use Group III.**
- 5. The dead load of each level (floor or roof), supported laterally by the shear walls, shall not be more than 25 psf. Where attics are not habitable, the dead load of a pitched roof shall include the dead load of the attic floor.**

**2305.3.2 Deflection.** Permissible deflection shall be that deflection up to which the shear wall and any attached distributing or resisting element will maintain its structural integrity under design load conditions, i.e., continue to support design loads without danger to occupants of the structure.

The deflection ( $\Delta$ ) of a blocked wood structural panel shear wall uniformly fastened throughout is permitted to be calculated by the use of the following formula:

$$\Delta = \frac{8vh^3}{EAb} + \frac{vh}{Gt} + 0.75he_n + d_a \quad \text{(Equation 23-2)}$$

$$\text{For SI: } \Delta = \frac{vh^3}{3EAb} + \frac{vh}{Gt} + \frac{he_n}{406.7} + d_a$$

where:

- $A$  = Area of boundary element cross section in square inches ( $\text{mm}^2$ ) (vertical member at shear wall boundary).
- $b$  = Wall width, in feet (mm).
- $d_a$  = Deflection due to anchorage details (rotation and slip at tie-down bolts).
- $E$  = Elastic modulus of boundary element (vertical member at shear wall boundary), in pounds per square inch ( $\text{N/mm}^2$ ).
- $e_n$  = Deformation of mechanically fastened connections, in inches ( $\text{mm}^2$ ). **[Note the reference in IBC 2004 Supplement to Table 2305.2.2(2) should be to Table 2305.2.2(1)].**
- $G$  = Modulus of rigidity of wood structural panel, in pounds per square inch ( $\text{N/mm}^2$ ).
- $h$  = Wall height, in feet (mm).
- $t$  = Effective thickness of wood structural panel for shear, in inches (mm).

$v$  = Maximum shear due to design loads at the top of the wall, in pounds per lineal foot (N/mm).

$\Delta$  = The calculated deflection, in inches (mm).

**2305.3.3 Shear wall aspect ratios.** Size and shape of shear walls and shear wall segments within shear walls containing openings shall be limited as set forth in Table 2305.3.3.

**TABLE 2305.3.3  
MAXIMUM SHEAR WALL ASPECT RATIOS**

**[Change footnote “b” per IBC 2004 Supplement]**

TYPE	MAXIMUM HEIGHT WIDTH RATIO
Wood structural panels or particleboard, nailed edges	For other than seismic: $3\frac{1}{2}$ For seismic: 2:1 <sup>a</sup>
Diagonal sheathing, single	2:1
Fiberboard, gypsum board, gypsum lath, cement plaster	$1\frac{1}{2}$ :1 <sup>b</sup>

a. For design to resist seismic forces, shear wall aspect ratios greater than 2:1 but not exceeding  $3\frac{1}{2}$ :1, are permitted provided that the factored shear resistance values in 2306.4.1 are multiplied by  $2w/h$ .

b. Ratio shown is for unblocked construction. Aspect ratio is permitted to be 2:1 where the wall is installed as blocked construction in accordance with Section 2306.4.5.1.2.

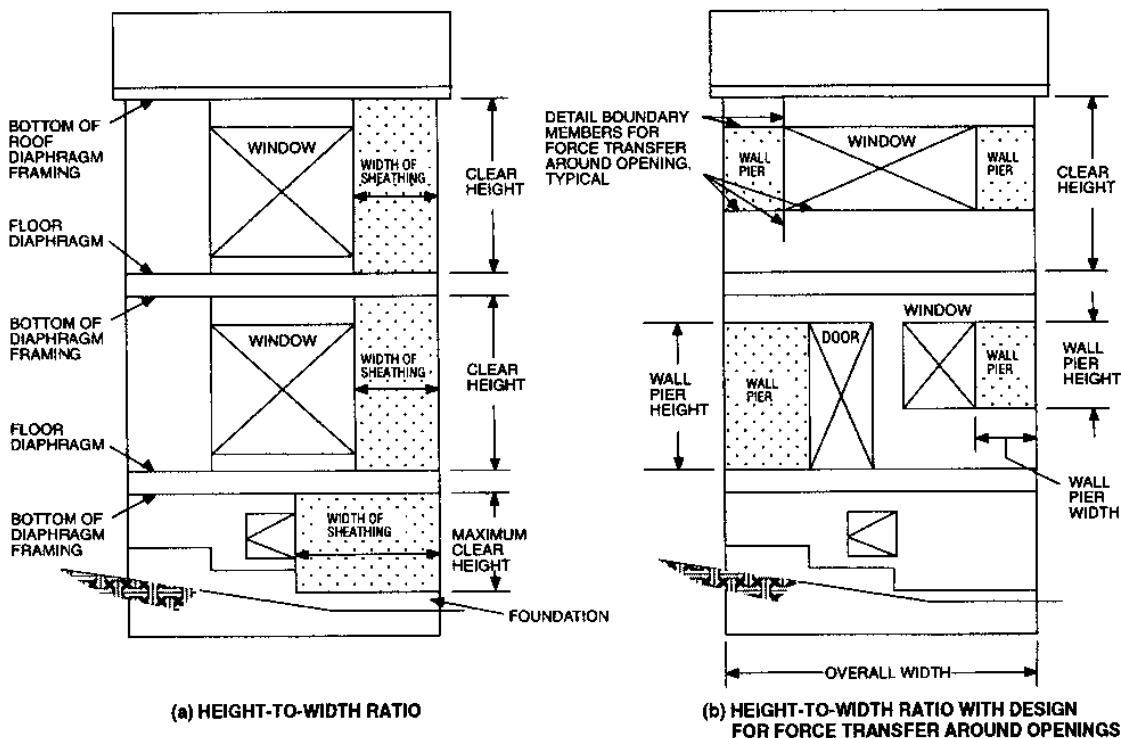
**2305.3.4 Shear wall height definition.** The height of a shear wall shall be defined as:

1. The maximum clear height from top of foundation to bottom of diaphragm framing above; or
2. The maximum clear height from top of diaphragm to bottom of diaphragm framing above. See Figure 2305.3.4(a).

**2305.3.4.1 AND 2305.3.4.2 [Add per IBC 2004 Supplement].**

**2305.3.5 Shear wall width definition.** The width of a shear wall shall be defined as the sheathed dimension of the shear wall in the direction of application of force. See Figure 2305.3.4(a).

**2305.3.5.1 Shear wall segment width definition.** The width of full-height sheathing adjacent to unrestrained openings in a shear wall.



**FIGURE 2305.3.4**  
**GENERAL DEFINITION OF SHEAR WALL HEIGHT, WIDTH AND HEIGHT-TO-WIDTH RATIO**

*[Change figure titles per 2004 IBC Supplement].*

**2305.3.6 Overturning restraint.** *Where the dead load stabilizing moment in accordance with Chapter 16 design load combinations is not sufficient to prevent uplift due to overturning moments on the wall, an anchoring device shall be provided. Anchoring devices shall maintain a continuous load path from the roof to the foundation.*

**2305.3.7 Shear walls with openings.** The provisions of this section shall apply to the design of shear walls with openings. Where framing and connections around the openings are designed for force transfer around the openings, the provisions of Section 2305.3.7.1 shall apply. Where framing and connections around the opening are not designed for force transfer around the openings, the provisions of Section 2305.3.7.2 shall apply.

**2305.3.7.1 Force transfer around openings.** Where shear walls with openings are designed for force transfer around the openings, the limitations of Table 2305.3.3 shall apply to the overall shear wall including openings and to each wall pier at the side of an opening. The height of a wall pier shall be defined as the clear height of the pier at the side of an opening. The width of a wall pier shall be defined as the sheathed width of the pier at the side of an opening. Design for force transfer shall be based on a rational

analysis. Detailing of boundary elements around the opening shall be provided in accordance with the provisions of this section. See Figure 2305.3.4(b).

**2305.3.7.2 Perforated shear walls.** The provisions of Section 2305.3.7.2 shall be permitted to be used for the design of perforated shear walls.

**2305.3.7.2.1 Limitations.** The following limitations shall apply to the use of Section 2305.3.7.2:

1. A perforated shear wall segment shall be located at each end of a perforated shear wall. Openings shall be permitted to occur beyond the ends of the perforated shear wall; however, the width of such openings shall not be included in the width of the perforated shear wall.
2. The allowable shear set forth in Table 2306.4.1 shall not exceed 490 plf (7150 N/m).
3. Where out-of-plane offsets occur, portions of the wall on each side of the offset shall be considered as separate perforated shear walls.
4. Collectors for shear transfer shall be provided through the full length of the perforated shear wall.
5. A perforated shear wall shall have uniform top of wall and bottom of wall elevations. Perforated shear walls not having uniform elevations shall be designed by other methods.
6. Perforated shear wall height,  $h$ , shall not exceed 20 feet (6096 mm).

**2305.3.7.2.2 Perforated shear wall resistance.** The resistance of a perforated shear wall shall be calculated in accordance with the following:

1. The percent of full-height sheathing shall be calculated as the sum of the widths of perforated shear wall segments divided by the total width of the perforated shear wall including openings.
2. The maximum opening height shall be taken as the maximum opening clear height. Where areas above and below an opening remain unsheathed, the height of opening shall be defined as the height of the wall.
3. The adjusted shear resistance shall be calculated by multiplying the unadjusted shear resistance by the shear resistance adjustment factors of Table 2305.3.7.2. For intermediate percentages of full-height sheathing, the values in Table 2305.3.7.2 are permitted to be interpolated.
4. The perforated shear wall resistance shall be equal to the adjusted shear resistance times the sum of the widths of the perforated shear wall segments.

**2305.3.7.2.3 Anchorage and load path.** Design of perforated shear wall anchorage and load path shall conform to the requirements of Sections 2305.3.7.2.4 through 2305.3.7.2.8, or shall be calculated using principles of mechanics. Except as modified by these sections, wall framing, sheathing, sheathing attachment and fastener schedules shall conform to the requirements of Section 2305.2.4 and Table 2306.4.1.

**2305.3.7.2.4 Uplift anchorage at perforated shear wall ends.** Anchorage for uplift forces due to overturning shall be provided at each end of the perforated shear wall.

The uplift anchorage shall conform to the requirements of Section 2305.3.6 except that for each story the minimum tension chord uplift force,  $T$ , shall be calculated in accordance with the following:

$$T = VH/C_o \Sigma L_i \quad \text{(Equation 23-3)}$$

where:

$T$  = Tension chord uplift force, pounds (N).

$V$  = Shear force in perforated shear wall, pounds (N).

$h$  = Shear wall height, feet (mm).

$C_o$  = Shear resistance adjustment factor from Table 2305.3.7.2.

$\Sigma L_i$  = Sum of widths of perforated shear wall segments, feet (mm).

**2305.3.7.2.5 Anchorage for in-plane shear.** The unit shear force,  $v$ , transmitted into the top of a perforated shear wall, out of the base of the perforated shear wall at full-height sheathing and into collectors (drag struts) connecting shear wall segments, shall be calculated in accordance with the following:

$$v = V/C_o \Sigma L_i \quad \text{(Equation 23-4)}$$

where:

$v$  = Unit shear force, pounds per lineal feet (N/m).

$V$  = Shear force in perforated shear wall, pounds (N).

$C_o$  = Shear resistance adjustment factor from Table 2305.3.7.2.

$\Sigma L_i$  = Sum of widths of perforated shear wall segments, feet (mm).

**2305.3.7.2.6 Uplift anchorage between perforated shear wall ends.** In addition to the requirements of Section 2305.3.7.2.4, perforated shear wall bottom plates at full-height sheathing shall be anchored for a uniform uplift force,  $t$ , equal to the unit shear force,  $v$ , determined in Section 2305.3.7.2.5.

**2305.3.7.2.7 Compression chords.** Each end of each perforated shear wall segment shall be designed for a compression chord force,  $C$ , equal to the tension chord uplift force,  $T$ , calculated in Section 2305.3.7.2.4.

**2305.3.7.2.8 Load path.** A load path to the foundation shall be provided for each uplift force,  $T$  and  $t$ , for each shear force,  $V$  and  $v$ , and for each compression chord force,  $C$ . Elements resisting shear wall forces contributed by multiple stories shall be designed for the sum of forces contributed by each story.

**2305.3.7.2.9 Deflection of shear walls with openings.** The controlling deflection of a blocked shear wall with openings uniformly nailed throughout shall be taken as the maximum individual deflection of the shear wall segments calculated in accordance with Section 2305.3.2, divided by the appropriate shear resistance adjustment factors of Table 2305.3.7.2.



**TABLE 2305.3.7.2  
SHEAR RESISTANCE ADJUSTMENT FACTOR,  $C_o$**

WALL HEIGHT, H	MAXIMUM OPENING HEIGHT <sup>a</sup>				
	H/3	H/2	2H/3	5H/6	H
8' wall	2'-8"	4'-0"	5'-4"	6'-8"	8'-0"
10' wall	3'-4"	5'-0"	6'-8"	8'-4"	10'-0"
Percent full-height sheathing <sup>b</sup>	Shear resistance adjustment factor				
10%	1.00	0.69	0.53	0.43	0.36
20%	1.00	0.71	0.56	0.45	0.38
30%	1.00	0.74	0.59	0.49	0.42
40%	1.00	0.77	0.63	0.53	0.45
50%	1.00	0.80	0.67	0.57	0.50
60%	1.00	0.83	0.71	0.63	0.56
70%	1.00	0.87	0.77	0.69	0.63
80%	1.00	0.91	0.83	0.77	0.71
90%	1.00	0.95	0.91	0.87	0.83
100%	1.00	1.00	1.00	1.00	1.00

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm.

a. See Section 2305.3.7.2.2, Item 2.

b. See Section 2305.3.7.2.2, Item 1.

**2305.3.8 Summing shear capacities.** The shear values for shear panels of different capacities applied to the same side of the wall are not cumulative except as allowed in Table 2306.4.1.

The shear values for material of the same type and capacity applied to both faces of the same wall are cumulative. Where the material capacities are not equal, the allowable shear shall be either two times the smaller shear capacity or the capacity of the stronger side, whichever is greater.

Summing shear capacities of dissimilar materials applied to opposite faces or to the same wall line is not allowed.

**Exception:** For wind design of structures described in the Exception to Section 2305.3.1, the allowable shear capacity of shear wall segments sheathed with a combination of wood structural panels and gypsum wall board on opposite faces shall equal the sum of the sheathing capacities of each face separately.

**2305.3.9 Adhesives.** Adhesive attachment of shear wall sheathing is not permitted as a substitute for mechanical fasteners, and shall not be used in shear wall strength calculations alone, or in combination with mechanical fasteners.

[For 2305.3.10 do not change from IBC 2003 text to IBC 2004 Supplement text].

**2305.3.10 Sill plate size and anchorage.** Two inch (51 mm) nominal wood sill plates for shear walls shall include steel plate washers, a minimum of  $\frac{3}{16}$  inch by 2 inches by 2 inches (4.76 mm by 51 mm by 51 mm) in size, between the sill plate

**and nut. Sill plates resisting a design load greater than 490 plf (LRFD) (7154 N/m) or 350 plf (ASD) (5110 N/m) shall not be less than a 3 inch (76 mm) nominal member. Where a single 3 inch (76 mm) nominal sill plate is used, 2-20d box end nails shall be substituted for 2-16d common end nails found in line 8 of Table 2304.5.**

**Exception:** In shear walls where the design load is less than 840 plf (LRFD) (12 264 N/m) or 600 plf (ASD) (8760 N/m), the sill plate is permitted to be a 2 inch (51 mm) nominal member if the sill plate is anchored by two times the number of bolts required by design and  $\frac{3}{16}$  inch by 2 inches by 2 inches (4.76 mm by 51 mm by 51 mm) plate washers are used..

## **SECTION 2306 CAPACITY AND CONSTRUCTION OF LATERAL FORCE RESISTING SYSTEMS**

**2306.1 General criteria.** The capacities given in this section are for ASD. For LRFD (strength design), the nominal strength (reference resistance) is equal to the allowable shear capacities given in this section times 2.0. The factored resistance is the nominal strength multiplied by the resistance factor,  $\phi$ , equal to 0.65.

**2306.1.1 Adjustment of design values.** The values in the tables of this section are for the Temperature Factor,  $C_t$ , equal 1.0 and the Wet Service factor,  $C_M$ , equal 1.0. The values in the tables shall be adjusted for conditions when these factors are less than 1.0. The values in the tables have been adjusted for load duration; no further adjustments are permitted.

**[Section 2306.2 to the end of Section 2306 is based on IBC 2003. Make IBC 2004 Supplement revisions. Then, revise the text as shown].**

### **2306.2 Wind provisions for walls.**

**2306.2.1 Wall stud bending stress increase.** *The NDS fiber stress in bending ( $F_b$ ) design values for wood studs resisting out of plane wind load can be increased by the factors in Table 2306.2.1, in lieu of the 1.15 repetitive member factor, to take into consideration the load sharing and composite actions provided by the wood structural panels as defined in Section 2302.1, where the studs are spaced no more than 16 inches (406 mm) on center, covered on the inside with a minimum of  $\frac{1}{2}$  inch (12.7 mm) gypsum board fastened in accordance with Table 2306.4.5, and sheathed on the exterior with a minimum of  $\frac{3}{8}$  inch (9.5 mm) wood structural panel sheathing that is attached to the studs using a minimum of 8d common nails spaced a maximum of 6 inches on center (152 mm) at panel edges and 12 inches on center (305 mm) in the field of the panels.*

**TABLE 2306.2.1  
WALL STUD BENDING STRESS INCREASE FACTORS**

STUD SIZE	SYSTEM FACTOR
2 x 4	1.5
2 x 6	1.4
2 x 8	1.3
2 x 10	1.2
2 x 12	1.15

### 2306.3 Wood diaphragms.

**2306.3.1 Shear capacities modifications.** The allowable shear capacities in Tables 2306.3.1, 2306.3.1a, and 2306.3.1b for horizontal wood structural panel diaphragms shall be increased 40 percent for wind design.

**2306.3.2 Wood structural panel diaphragms.** *Structural panel diaphragms with wood structural panels are permitted to be used to resist horizontal forces not exceeding those set forth in Tables 2306.3.1, 2306.3.1a, 2306.3.1b or 2306.3.2.*

**2306.3.3 Diagonally sheathed lumber diaphragms.** Diagonally sheathed lumber diaphragms shall be nailed in accordance with Table 2306.3.3.

**2306.3.4 Single diagonally sheathed lumber diaphragms.** Single diagonally sheathed lumber diaphragms shall be constructed of minimum 1-inch (25 mm) thick nominal sheathing boards laid at an angle of approximately 45 degrees (0.78 radians) to the supports. The shear capacity for single diagonally sheathed lumber diaphragms of southern pine or Douglas fir-larch shall not exceed 300 pounds per linear foot (4378 N/m) of width. The shear capacities shall be adjusted by reduction factors of 0.82 for framing members of species with a specific gravity equal to or greater than 0.42 but less than 0.49 and 0.65 species with a specific gravity of less than 0.42, as contained in the NDS.

**2306.3.4.1 End joints.** End joints in adjacent boards shall be separated by at least one stud or joist space and there shall be at least two boards between joints on the same support.

**2306.3.4.2 Single diagonally sheathed lumber diaphragms.** Single diagonally sheathed lumber diaphragms made up of 2-inch (51 mm) nominal diagonal lumber sheathing fastened with 16d nails shall be designed with the same shear capacities as shear panels using 1-inch (25 mm) boards fastened with 8d nails, provided there are not splices in adjacent boards on the same support and the supports are not less than 4 inch (102 mm) nominal depth or 3 inch (76 mm) nominal thickness.

**2306.3.5 Double diagonally sheathed lumber diaphragms.** Double diagonally sheathed lumber diaphragms shall be constructed of two layers of diagonal sheathing boards at 90 degrees (1.57 rad) to each other on the same face of the supporting members. Each chord shall be considered as a beam with uniform load per foot equal to 50 percent of the unit shear due to diaphragm action. The load shall be assumed as acting normal to the chord in the plan of the diaphragm in either direction. The span of the chord or portion thereof shall be the distance between framing members of the diaphragm, such as the joists, studs, and blocking that serve to transfer the assumed load to the sheathing. The shear capacity of double diagonally sheathed diaphragms of southern pine or Douglas fir-larch shall not exceed 600 pounds per linear foot (8756 kN/m) of width. The shear capacity shall be adjusted by reduction factors of 0.82 for framing members of species with a specific gravity equal to or greater than 0.42 but less than 0.49 and 0.65 for species with a specific gravity of less than 0.42, as contained in the NDS. Nailing of diagonally sheathed lumber diaphragms shall be in accordance with Table 2306.3.3.

***2306.3.6 Gypsum board diaphragm ceilings. Gypsum board diaphragm ceilings shall be in accordance with Section 2508.5, but may only be used for ceilings below attics without floor diaphragms.***

**2306.4 Shear walls.** See Section 2305.3.1 for limitations on shear wall bracing materials. Panel sheathing joints in shear walls shall occur over studs or blocking. Adjacent panel sheathing joints shall occur over and be nailed to common framing members.

***2306.4.1 Wood structural panel shear walls. Wood structural panels shall be fastened directly to wood framing; fastening through other sheathing materials is not permitted. The allowable shear capacities for wood structural panel shear walls shall be in accordance with Tables 2306.4.1, 2306.4.1a, and 2304.1b. These capacities are permitted to be increased 40 percent for wind design.***

***2306.4.2 Lumber sheathed shear walls. Single and double diagonally sheathed lumber diaphragms shall be in accordance with the construction and allowable load provisions of Sections 2306.3.4 and 2306.3.5.***

***2306.4.3 Particleboard shear walls. The design shear capacity of particleboard shear walls shall be in accordance with Table 2306.4.3. Shear panels shall be constructed with particleboard sheets not less than 4 by 8 feet (1219 by 2438 mm), except at boundaries and changes in framing. Particleboard panels shall be designed to resist shear only, and chords, collector members, and boundary elements shall be connected at all corners. Panel edges shall be backed with 2-inch (51 mm) nominal or wider framing. Sheets are permitted to be installed either horizontally or vertically. For  $\frac{3}{8}$ -inch (9.5 mm) particleboard sheets installed with the long dimension parallel to the studs spaced 24 inches (610 mm) on center along intermediate framing members. For all other conditions, nails of the same***

**size shall be spaced at 12 inches (305 mm) on center along intermediate framing members. Particleboard panels less than 12 inches (305 mm) wide shall be blocked.**

**2306.4.4 Fiberboard shear walls.** *The design shear capacity of fiberboard shear walls shall be in accordance with Table 2308.9.3(4). The fiberboard sheathing shall be applied vertically or horizontally to wood studs not less than 2-inch (51 mm) nominal thickness spaced 16 inches (406 mm) on center. Blocking not less than 2-inch (51 mm) nominal in thickness shall be provided at horizontal joints.*

**2306.4.5 Shear walls sheathed with other materials.** *Shear capacities for walls sheathed with lath and plaster, and gypsum board shall be in accordance with Table 2306.4.5. Shear walls sheathed with lath, plaster and gypsum board shall be constructed in accordance with Chapter 25 and Section 2306.4.5.1.*

**2306.4.5.1 Application of gypsum board or lath and plaster to wood framing.**

**2306.4.5.1.1 Joint staggering.** End joints of adjacent courses of gypsum board shall not occur over the same stud.

**2306.4.5.1.2 Blocking.** Where required in Table 2306.4.5, wood blocking having the same cross-sectional dimensions as the studs shall be provided at joints that are perpendicular to the studs.

**2306.4.5.1.3 Nailing.** Studs, top and bottom plates and blocking shall be nailed in accordance with Table 2304.9.1.

**2306.4.5.1.4 Fasteners.** The size and spacing of nails shall be set forth in Table 2306.4.5. Nails shall be spaced not less than  $\frac{3}{8}$  inch (9.5 mm) from edges and ends of gypsum boards or sides of studs, blocking and top and bottom plates.

**2306.4.5.1.5 Gypsum lath.** Gypsum lath shall be applied perpendicular to the studs. Maximum allowable shear values shall be set forth in Table 2306.4.5.

**2306.4.5.1.6 Gypsum sheathing.** Four-foot-wide (1219 mm) pieces of gypsum sheathing shall be applied parallel or perpendicular to studs. Two-foot-wide (610 mm) pieces of gypsum sheathing shall be applied perpendicular to the studs. Maximum allowable shear values shall be as set forth in Table 2306.4.5.

**2306.4.5.1.7 Other gypsum boards.** Gypsum board shall be applied parallel or perpendicular to studs. Maximum allowable shear values shall be set forth in Table 2306.4.5.

[Revise Tables 2306.3.1, 2306.3.2, 2306.4.1, 2306.4.3, and 2306.4.5 per IBC 2004 Supplement. Note that right hand section of Table 2306.4.1 is deleted as shown].

[Sections 2307 and 2308 not used in document].

TABLE 2306.3.1  
RECOMMENDED SHEAR (POUNDS PER FOOT) FOR WOOD STRUCTURAL PANEL DIAPHRAGMS  
WITH FRAMING OF DOUGLAS-FIR-LARCH, OR SOUTHERN PINE<sup>a</sup> FOR WIND OR SEISMIC LOADING

PANEL GRADE	COMMON NAIL SIZE OR STAPLE <sup>f</sup> LENGTH AND GAGE	MINIMUM FASTENER PENETRATION IN FRAMING (inches)	MINIMUM NOMINAL PANEL THICKNESS (inch)	MINIMUM NOMINAL WIDTH OF FRAMING MEMBER (inches)	BLOCKED DIAPHRAGMS					UNBLOCKED DIAPHRAGMS				
					Fastener spacing (inches) at diaphragm boundaries (all cases) at continuous panel edges parallel to load (Cases 3, 4), and at all panel edges (Cases 5 and 6) <sup>b</sup>					Fasteners spaced 6" max. at supported edges <sup>b</sup>				
					6	4	2-1/2 <sup>c</sup>	2 <sup>c</sup>						
									Fastener spacing (inches) at other panel edges (Cases 1, 2, 3 and 4) <sup>b</sup>				Case 1 (No unblocked edges or continuous joints parallel to load)	All other configurations (Cases 2, 3, 4, 5 and 6)
									6	6	4	3		
Structural I Grades	6d <sup>e</sup>	1 1/4	5/16	2	185	250	375	420	165	125				
				3	210	280	420	475	185	140				
	1 1/2 16 Gage	1		2	155	205	310	350	135	105				
				3	175	230	345	390	155	115				
	8d	1 3/8	3/8	2	270	360	530	600	240	180				
				3	300	400	600	675	265	200				
	1 1/2 16 Gage	1		2	175	235	350	400	155	115				
				3	200	265	395	450	175	130				
Sheathing, Single Floor and Other Grades Covered in DOC PS 1 and PS 2	10d <sup>d</sup>	1 1/2	15/32	2	320	425	640	730	285	215				
				3	360	480	720	820	320	240				
	1 1/2 16 Gage	1		2	175	235	350	400	155	120				
				3	200	265	395	450	175	130				
	6d <sup>e</sup>	1 1/4	5/16	2	170	225	335	380	150	110				
				3	190	250	380	430	170	125				
	1 1/2 16 Gage	1		2	140	185	275	315	125	90				
				3	155	205	310	350	140	105				
	6d <sup>e</sup>	1 1/4	3/8	2	185	250	375	420	165	125				
				3	210	280	420	475	185	140				
	8d	1 3/4		2	240	320	480	545	215	160				
				3	270	360	540	610	240	180				

(continued)

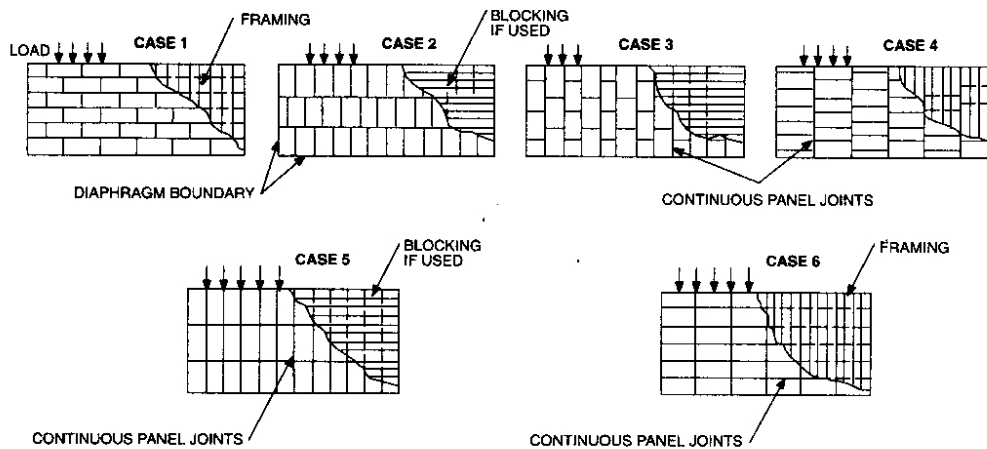
TABLE 2306.3.1 — continued  
RECOMMENDED SHEAR (POUNDS PER FOOT) FOR WOOD STRUCTURAL PANEL DIAPHRAGMS  
WITH FRAMING OF DOUGLAS-FIR-LARCH, OR SOUTHERN PINE<sup>a</sup> FOR WIND OR SEISMIC LOADING

PANEL GRADE	COMMON NAIL SIZE OR STAPLE LENGTH AND GAGE	MINIMUM FASTENER PENETRATION IN FRAMING (inches)	MINIMUM NOMINAL PANEL THICKNESS (inch)	MINIMUM NOMINAL WIDTH OF FRAMING MEMBER (inches)	BLOCKED DIAPHRAGMS					UNBLOCKED DIAPHRAGMS	
					Fastener spacing (inches) at diaphragm boundaries (all cases) at continuous panel edges parallel to load (Cases 3, 4), and at all panel edges (Cases 5 and 6) <sup>b</sup>					Fasteners spaced 6" max. at supported edges <sup>b</sup>	
					6	4	2-1/2 <sup>c</sup>	2 <sup>c</sup>	Case 1 (No unblocked edges or continuous joints parallel to load)	All other configurations (Cases 2, 3, 4, 5 and 6)	
					6	6	4	3			
Sheathing, Single Floor and other grades covered in DOC PS 1 and PS 2 (continued)	1 1/2 16 Gage	1	3/8	2 3	160 180	210 235	315 355	360 400	140 160	105 120	
	8d	1 3/8		2 3	255 285	340 380	505 570	575 645	230 255	170 190	
	1 1/2 16 Gage	1	7/16	2 3	165 190	225 250	335 375	380 425	150 165	110 125	
	8d	1 3/8		2 3	270 300	360 400	530 600	600 675	240 265	180 200	
	10d <sup>d</sup>	1 1/2	15/32	2 3	290 325	385 430	575 650	655 735	255 290	190 215	
	1 1/2 16 Gage	1		2 3	160 180	210 235	315 355	360 405	140 160	105 120	
	10d <sup>d</sup>	1 1/2		2 3	320 360	425 480	640 720	730 820	285 320	215 240	
	1 3/4 16 Gage	1	19/32	2 3	175 200	235 265	350 395	400 450	155 175	115 130	

(continued)



**TABLE 2306.3.1—continued**  
**RECOMMENDED SHEAR (POUNDS PER FOOT) FOR WOOD STRUCTURAL PANEL DIAPHRAGMS**  
**WITH FRAMING OF DOUGLAS-FIR-LARCH, OR SOUTHERN PINE<sup>a</sup> FOR WIND OR SEISMIC LOADING**



For SI: 1 inch = 25.4 mm, 1 pound per foot = 14.5939 N/m.

- For framing of other species: (1) Find specific gravity for species of lumber in AFPA National Design Specification. (2) For staples find shear value from table above for Structural I panels (regardless of actual grade) and multiply value by 0.82 for species with specific gravity of 0.42 or greater, or 0.65 for all other species. (3) For nails find shear value from table above for nail size for actual grade and multiply value by the following adjustment factor: Specific Gravity Adjustment Factor =  $[1 - (0.5 - SG)]$ , Where SG = Specific Gravity of the framing lumber. This adjustment factor shall not be greater than 1.
- Space nails maximum 12 inches o.c. along intermediate framing members (6 inches o.c. where supports are spaced 48 inches o.c.).
- Framing at adjoining panel edges shall be 3-inches nominal or wider, and nails shall be staggered where nails are spaced 2 inches o.c. or 2 1/2 inches o.c.
- Framing at adjoining panel edges shall be 3-inch nominal or wider, and nails shall be staggered where both of the following conditions are met: (1) 10d nails having penetration into framing of more than 1 1/2 inches and (2) nails are spaced 3 inches o.c. or less.
- 8d is recommended minimum for roofs due to negative pressures of high winds.
- Staples shall have a minimum crown width of 7/16 inch.

**[Insert TABLES 2306.3.1a and 2306.3.1b after Table 2306.3.1; they are in Excel format in separate file. Make same revisions to them as is done for Table 2306.3.1 in accordance with the IBC 2004 Supplement].**

**TABLE 2306.3.2**  
**ALLOWABLE SHEAR IN POUNDS PER FOOT FOR HORIZONTAL BLOCKED DIAPHRAGMS**  
**UTILIZING MULTIPLE ROWS OF FASTENERS (HIGH LOAD DIAPHRAGMS) WITH FRAMING OF DOUGLAS FIR,**  
**LARCH OR SOUTHERN PINE<sup>a</sup> FOR WIND OR SEISMIC LOADING<sup>b</sup>**

BLOCKED DIAPHRAGMS												
Cases 1 and 2 <sup>d</sup>												
Fastener Spacing Per Line at Boundaries (inches)												
42 <sup>1/2</sup>												
Fastener Spacing Per Line at Other Panel Edges (inches)												
6444332												
PANEL GRADE <sup>c</sup>	FASTENER AND SIZE	MINIMUM NAIL PENETRATION IN FRAMING (inches)	MINIMUM NOMINAL PANEL THICKNESS (inch)	MINIMUM NOMINAL WIDTH OF FRAMING MEMBER <sup>e</sup> (inches)	LINES OF FASTENERS							
						6	4	4	4	3	3	2
Structural I grades	10d common nails	1 <sup>1/2</sup>	15 <sup>1</sup> / <sub>32</sub>	3	2	605	815	875	1,150	—	—	—
				4	2	700	915	1,005	1,290	—	—	—
				4	3	875	1,220	1,285	1,395	—	—	—
			19 <sup>1</sup> / <sub>32</sub>	3	2	670	880	965	1,255	—	—	—
				4	2	780	990	1,110	1,440	—	—	—
				4	3	965	1,320	1,405	1,790	—	—	—
	14 gage staples	2	23 <sup>1</sup> / <sub>32</sub>	3	2	730	955	1,050	1,365	—	—	—
				4	2	855	1,070	1,210	1,565	—	—	—
				4	3	1,050	1,430	1,525	1,800	—	—	—
				3	2	600	600	860	960	1,060	1,200	1,200
Sheathing single floor and other grades covered in DOC PS 1 and PS 2	10d common nails	1 <sup>1/2</sup>	15 <sup>1</sup> / <sub>32</sub>	3	2	600	600	875	960	1,075	1,200	1,200
				4	2	875	900	1,175	1,440	1,475	1,795	1,795
				4	3	525	725	765	1,010	—	—	—
			19 <sup>1</sup> / <sub>32</sub>	3	2	605	815	875	1,105	—	—	—
				4	2	765	1,085	1,130	1,195	—	—	—
				3	2	650	860	935	1,225	—	—	—
	14 gage staples	2	23 <sup>1</sup> / <sub>32</sub>	4	2	755	965	1,080	1,370	—	—	—
				4	3	935	1,290	1,365	1,485	—	—	—
				3	2	710	935	1,020	1,335	—	—	—
				4	2	825	1,050	1,175	1,445	—	—	—
PS 1 and PS 2	14 gage staples	2	15 <sup>1</sup> / <sub>32</sub>	3	2	1,020	1,400	1,480	1,565	—	—	—
				4	3	540	540	735	865	915	1,080	1,080
				4	3	735	810	1,005	1,105	1,105	1,195	1,195
			19 <sup>1</sup> / <sub>32</sub>	3	2	600	600	865	960	1,065	1,200	1,200
				4	3	865	900	1,130	1,430	1,370	1,485	1,485
				4	3	865	900	1,130	1,430	1,370	1,485	1,485

For SI: 1 inch = 25.4 mm.

a. For framing of the other species: (1) Find specific gravity for species of framing lumber in AFPA National Design Specification, (2) Find shear value from table above for nail size of actual grade, and (3) Multiply value by the following adjustment factor =  $[1 - 0.5 \cdot SG]$ , where  $SG$  = Specific gravity of the framing lumber. This adjustment factor shall not be greater than 1.

b. Fastening along intermediate framing members: Space nails 12 inches on center, except 6 inches on center for spans greater than 32 inches.

c. Panels conforming to PS 1 or PS 2.

d. This table gives shear values for Cases 1 and 2 as shown in Table 2306.3.1. The values shown are applicable to Cases 3, 4, 5 and 6 as shown in Table 2306.3.1, providing fasteners at all continuous panel edges are spaced in accordance with the boundary fastener spacing.

e. The minimum depth of framing members shall be 3 inches.

**TABLE 2306.3.3  
DIAGONALLY SHEATHED LUMBER DIAPHRAGM NAILING SCHEDULE**

SHEATHING NOMINAL DIMENSION	NAILING TO INTERMEDIATE AND END BEARING STUDS		NAILING AT THE SHEAR PANEL BOUNDARIES	
	Type, size and number of nails per board			
	Common nails	Box nails	Common nails	Box nails
1 × 6	two 8d	three 8d	three 8d	five 8d
1 × 8	three 8d	four 8d	four 8d	six 8d
2 × 6	two 16d	three 16d	three 16d	five 16d
2 × 8	three 16d	four 16d	four 16d	six 16d

TABLE 2306.4.1  
ALLOWABLE SHEAR (POUNDS PER FOOT) FOR WOOD STRUCTURAL PANEL SHEAR WALLS  
WITH FRAMING OF DOUGLAS-FIR-LARCH, OR SOUTHERN PINE<sup>a</sup> FOR WIND OR SEISMIC LOADING<sup>b, h, i, j</sup>

PANEL GRADE	MINIMUM NOMINAL PANEL THICKNESS (inches)	MINIMUM FASTENER PENETRATION IN FRAMING (inches)	PANELS APPLIED DIRECT TO FRAMING					PANEL APPLIED OVER 1/2" OR 5/8" GYPSUM SHEATH <sup>h</sup>		
			Nail (common or galvanized box) or staple size <sup>k</sup>	Fastener spacing at panel edges (inches)				Fastener spacing at panel edges (inches)		
				6	4	3	2 <sup>e</sup>	6	4	3
Structural I Sheathing	5/16	1 1/4	6d	200	300	390	510	200	300	3
		1	1 1/2 16 Gage	165	245	325	415	125	185	10
	3/8	1 3/8	8d	230 <sup>d</sup>	360 <sup>d</sup>	460 <sup>d</sup>	610 <sup>d</sup>	0	430	315
		1	1 1/2 16 Gage	155	235	315	400	—	235	730
	7/16	1 3/8	8d	255 <sup>d</sup>	395 <sup>d</sup>	505 <sup>d</sup>	670 <sup>d</sup>	—	43 <sup>f</sup>	400
		1	1 1/2 16 Gage	170	260	345	440	—	—	730
	1 5/32	1 3/8	8d	280	430	550 <sup>f</sup>	730	—	—	400
		1	10d	340	510	665 <sup>f</sup>	870	—	—	730
	5/16 or 1/4 <sup>c</sup>	1 3/8	1 1/2 16 Gage	185	280	375	475	—	—	—
		1 1/2	10d	340	510	665 <sup>f</sup>	870	—	—	—
Sheathing, Plywood Siding <sup>g</sup> except Group 5 Species	3/8	1 1/4	6d	145	220	295	375	—	—	—
		1 3/8	8d	200	300	390	510	—	—	—
	7/16	1	1 1/2 16 Gage	140	210	280	360	—	—	—
		1 3/8	8d	240 <sup>d</sup>	350 <sup>d</sup>	450 <sup>d</sup>	585 <sup>d</sup>	—	—	—
	1 5/32	1	1 1/2 16 Gage	155	230	310	395	—	—	—
		1 3/8	8d	260	380	490 <sup>f</sup>	640	—	—	—
	1 9/32	1 1/2	10d	310	460	600 <sup>f</sup>	770	—	—	—
		1	1 1/2 16 Gage	170	255	335	430	—	—	—
	1 1/2	1 1/2	10d	340	510	665 <sup>f</sup>	870	—	—	—
		1	1 3/4 16 Gage	185	280	375	475	—	—	—

(continued)

**TABLE 2306.4.1 — continued**  
**ALLOWABLE SHEAR (POUNDS PER FOOT) FOR WOOD STRUCTURAL PANEL SHEAR WALLS**  
**WITH FRAMING OF DOUGLAS-FIR-LARCH, OR SOUTHERN PINE<sup>a</sup> FOR WIND OR SEISMIC LOADING<sup>b, h, i, j</sup>**

PANEL GRADE	MINIMUM NOMINAL PANEL THICKNESS (inches)	MINIMUM FASTENER PENETRATION IN FRAMING (inches)	PANELS APPLIED DIRECT TO FRAMING				PANEL APPLIED OVER 1/2" OR 5/8" GYPSUM SHEAT <sup>c</sup>	
			Nail (common or galvanized box) or staple size <sup>k</sup>	Fastener spacing at panel edges (inches)			(galv. box) OR S. SIZE <sup>k</sup>	Fastener spacing at panel edges <sup>c</sup>
				6	4	3		
Sheathing, Plywood Siding <sup>g</sup> except Group 5 Species			Nail Size (galvanized casing)					
	5/16 <sup>e</sup>	1 1/4	6d	140	210	275		210
	3/4	1 3/8	8d	160	240	310 <sup>f</sup>	160	240 310 <sup>f</sup>

For SI: 1 inch = 25.4 mm, 1 pound per foot = 14.5939 N/m.

- For framing of other species: (1) Find specific gravity for species of lumber in NDS. (2) For staples find shear value from table above for Structural I panels (regardless of actual grade) and multiply value by 0.82 for species with specific gravity of 0.42 or greater, or 0.65 for all other species. (3) For nails find shear value from table above for actual grade and multiply value by the following adjustment factor: Specific Gravity Adjustment Factor =  $[1 - (0.5 - SG)]$ ; Where SG = Specific Gravity of the framing lumber. This adjustment factor shall not be greater than 1.
- Panel edges backed with 2-inch nominal or wider framing. Install panels either horizontally or vertically. Space nails maximum 6 inches o.c. along intermediate framing members for 3/4-inch and 7/16-inch panels installed on studs spaced 24 inches o.c. For other conditions and panel thickness, space nails maximum 12 inches o.c. on intermediate supports.
- 3/8-inch or siding 16 inches o.c. is minimum recommended where applied direct to framing as exterior siding.
- Shears are permitted to be increased to values shown for 1 1/2-inch sheathing with same nailing provided (a) studs are spaced a maximum of 16 inches o.c., or (b) if panels are applied with long dimension across studs.
- Framing at adjoining panel edges shall be 3-inch nominal or wider, and nails shall be staggered where nails are spaced 2 inches o.c.
- Framing at adjoining panel edges shall be 3-inch nominal or wider, and nails shall be staggered where both of the following conditions are met: (1) 10d nails having penetration into framing of more than 1 1/2 inches and (2) nails are spaced 3 inches o.c.
- Values apply to all-veneer plywood. Thickness at point of nailing on panel edges governs shear values.
- Where panels are applied on both faces of a wall and nail spacing is less than 6 inches o.c. on either side, panel joints shall be offset to fall on different framing members. Or framing shall be 3-inch nominal or thicker and nails on each side shall be staggered.
- In Seismic Design Category D, E or F, where shear design values exceed 490 plf (LRFD) or 350 plf (ASD) all framing members receiving edge nailing from abutting panels shall not be less than a single 3-inch nominal member. Plywood joint and sill plate nailing shall be staggered in all cases. See Section 2305.3.10 for sill plate size and anchorage requirements.
- Galvanized nails shall be hot-dipped or tumbled.
- Staples shall have a minimum crown width of 7/16 inch.

[Insert TABLES 2306.4.1a and 2306.4.1b after Table 2306.4.1; they are in Excel format in a separate file Make same revisions to them as is done for Table 2306.4.1 in accordance with the IBC 2004 Supplement].

**TABLE 2306.4.3  
ALLOWABLE SHEAR FOR PARTICLEBOARD SHEAR WALL SHEATHING**

PANEL GRADE	MINIMUM NOMINAL PANEL THICKNESS (inch)	MINIMUM NAIL PENETRATION IN FRAMING (inches)	PANELS APPLIED DIRECT TO FRAMING				
			Nail size (common or galvanized box)	Allowable shear (pounds per foot) nail spacing at panel edges (inches) <sup>a</sup>			
				6	4	3	2
M-S "Exterior Glue" and M-2 "Exterior Glue"	3/8	1 1/2	6d	120	180	230	300
	3/8	1 1/2	8d	130	190	240	315
	1/2			140	210	270	350
	1/2	1 5/8	10d	185	275	360	460
	5/8			200	305	395	520

For SI: 1 inch = 25.4 mm, 1 pound per foot = 14.5939 N/m.

a. Values are not permitted in Seismic Design Category D, E or F.

**TABLE 2306.4.5  
ALLOWABLE SHEAR FOR WIND OR SEISMIC FORCES FOR SHEAR WALLS OF LATH AND PLASTER OR GYPSUM BOARD WOOD-FRAMED WALL ASSEMBLIES**

TYPE OF MATERIAL	THICKNESS OF MATERIAL	WALL CONSTRUCTION	FASTENER SPACING <sup>b</sup> MAXIMUM (inches)	SHEAR VALUE <sup>a</sup> (PLF)	MINIMUM FASTENER SIZE <sup>c,d,j,k</sup>
1. Expanded metal or woven wire lath and portland cement plaster	7/8"	Unblocked	6	180	No. 11 gage 1 1/2" long, 7/16" head 16 Ga. Galv. Staple, 7/8" legs
2. Gypsum lath, plain or perforated	3/8" lath and 1/2" plaster	Unblocked	5	100	No. 13 gage, 1 1/8" long, 19/64" head, plasterboard nail  16 Ga. Galv. Staple, 1 1/8" long 0.120" Nail, min 3/8" head, 1 1/4" long
3. Gypsum Sheathing	1/2" x 2' x 8'	Unblocked	4	75	No. 11 gage, 1 3/4" long, 7/16" head, diamond-point, galvanized 16 Ga. Galv. Staple, 1 3/4" long
	1/2" x 4'	Blocked <sup>f</sup> Unblocked	4 7	175 100	
	5/8" x 4'	Blocked	4" edge/ 7" field	200	6d galvanized 0.120" Nail, min 3/8" head, 1 3/4" long
4. Gypsum board, gypsum veneer base, or water-resistant gypsum backing board	1/2"	Unblocked <sup>f</sup>	7	75	5d cooler or wallboard 0.120" Nail, min 3/8" head, 1 1/2" long
		Unblocked <sup>f</sup>	4	110	
		Unblocked	7	100	
		Unblocked	4	125	
		Blocked <sup>g</sup>	7	125	16 Gage Staple, 1 1/2" long
		Blocked <sup>g</sup>	4	150	
		Unblocked	8/2 <sup>h</sup>	60	
		Blocked <sup>g</sup>	4/16 <sup>h</sup>	160	
		Blocked <sup>g</sup>	4/12 <sup>h</sup>	155	
		Blocked <sup>f,g</sup>	8/12 <sup>h</sup>	70	
		Blocked <sup>g</sup>	6/12 <sup>h</sup>	90	No. 6-1 1/4" screws <sup>i</sup>

(continued)

**TABLE 2306.4.5—continued**  
**ALLOWABLE SHEAR FOR WIND OR SEISMIC FORCES FOR SHEAR WALLS OF LATH**  
**AND PLASTER OR GYPSUM BOARD WOOD-FRAMED WALL ASSEMBLIES**

TYPE OF MATERIAL	THICKNESS OF MATERIAL	WALL CONSTRUCTION	FASTENER SPACING <sup>b</sup> MAXIMUM (inches)	SHEAR VALUE <sup>a, e</sup> (PLF)	MINIMUM FASTENER SIZE <sup>c, d, j, k</sup>
4. Gypsum board, gypsum veneer base, or water-resistant gypsum backing board (continued)	5/8"	Unblocked <sup>f</sup>	7	115	6d cooler or wallboard 0.120" Nail, min 3/8" head, 1 3/4" long 16 Gage Staple, 1 1/2" legs, 1 5/8" long
			4	145	
		Blocked <sup>g</sup>	7	145	
			4	175	
		Blocked <sup>g</sup> Two-Ply	Base ply: 9 Face ply: 7	250	Base ply—6d cooler or wallboard 1 3/4" × 0.120" Nail, min 3/8" head 1 5/8" 16 Ga. Galv. Staple Face ply—8d cooler or wallboard 0.120" Nail, min 3/8" head, 2 3/8" long 15 Ga. Galv. Staple, 2 1/4" long
		Unblocked	8/12 <sup>h</sup>	70	No. 6-1 1/4" screws <sup>i</sup>
		Blocked <sup>g</sup>	8/12 <sup>h</sup>	90	

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound per foot = 14.5939 N/m.

- These shear walls shall not be used to resist loads imposed by masonry or concrete construction. See Section 2305.1.5. Values shown are for short-term loading due to wind or due to seismic loading in Seismic Design Categories A, B and C. Values shall be reduced 50 percent in Seismic Design Category D. Values not permitted in Seismic Design Category E or F. Values shown shall be reduced 25 percent for normal loading.
- Applies to nailing at studs, top and bottom plates and blocking.
- Alternate nails are permitted to be used if their dimensions are not less than the specified dimensions. Drywall screws are permitted to be substituted for the 5d, 6d (cooler) nails listed above. 1 1/4 inches Type S or W, #6 for 6d (cooler) nails.
- For properties of cooler nails, see ASTM C 514.
- Except as noted, shear values are based on a maximum framing spacing of 16 inches o.c.
- Maximum framing spacing of 24 inches o.c.
- All edges are blocked, and edge nailing is provided at all supports and all panel edges.
- First number denotes fastener spacing at the edges; second number denotes fastener spacing in the field.
- Screws are Type W or S.
- Staples shall have a minimum crown width of 7/16-inch, measured outside the legs.
- Staples for the attachment of gypsum lath and woven-wire lath shall have a minimum crown width of 3/4-inch, measured outside the legs.